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Engineering Library

The Engineer

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The Vermot Shunting Tractor.

Powdered Fuel.

London Water Supply.

PUBLIC NOTICES

G. R.

SALE BY TENDER.

Tenders are Invited for the following PLANT, situate at the R.E. Experimental Station, Porton, near Salisbury:—
10 K.W. GENERATING SET, by E. Scott and Mountain, consisting of
Vertical Twin Steam Engine, No. 707, 75 B.H.P., direct coupled to Tyne Dynamo, No. 2804, D.C., watts 220,250, amps. 272, r.p.m. 500, shunt wound. Engine and generator mounted on C.I. base.
Tenders should be marked "Generating Set" and sent to the
ROADS AND COMMUNICATIONS OFFICER,
Evelyn House, Wilton-road,
Salisbury,
to arrive not later than 1st January, 1924.
Any Tender not necessarily accepted. 4415

Crystal Palace School of PRACTICAL ENGINEERING.
Founded 1872.
PRINCIPAL: J. W. WILSON, M. Inst. C.E., M.I. Mech. E.
The NEW COURSE will COMMENCE on JANUARY 9th. 4413

Bengal-Nagpur Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for 2000 SPIRAL SPRINGS.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 27th December, 1923.
A fee of 10s. will be charged for the specification, which is not returnable.
Tenders must be submitted not later than Noon on Thursday, 10th January, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
R. C. VOLKERS,
4419 Secretary.

City of Hereford.
COMPETITION.
BUTTER MARKET RECONSTRUCTION.
The Hereford Town Council invite DESIGNS for the proposed RECONSTRUCTION of the MARKET HALL and ADJOINING PREMISES.
Full details, conditions, and site plan can be obtained from the undersigned on payment of £2 2s.
The Committee offer a premium of £100 for the best Design as adjudged by a competent member of the R.I.B.A.
The Committee do not bind themselves to proceed with the works, but, in the event of their doing so, the Architect whose design has been accepted will be appointed to carry out the works.
ROBERT BATTERSBY,
Town Clerk.
Town Hall, Hereford,
21st December, 1923. 4437

County Borough of Hastings.
ELECTRICAL DEPARTMENT.
TENDERS are INVITED for the SUPPLY, DELIVERY, and ERECTION of:—
STEEL CONSTRUCTIONAL BUILDINGS.
STEEL PLATE COAL BUNKERS AND CHUTES.
REINFORCED CONCRETE POND AND PLANT FOUNDATIONS.
Specification and Tender form will be available on application to the Borough Electrical Engineer, 20, South-terrace, Hastings.
Tenders, on prescribed forms, must be delivered to the undersigned not later than Noon, January 21st, 1924.
D. W. JACKSON,
Town Clerk.
Town Hall, Hastings,
December 21st, 1923. 4436

County of London.
SALE OF ELECTRICAL POWER STATION PLANT.
TENDERS are INVITED for the PURCHASE and REMOVAL of ELECTRIC CABLES and WIRE, PUMPS, PIPING and VALVES, BUNKERS, TANKS, FLUE, ECONOMISER, and WEIGHBRIDGE.
The plant may be inspected at the London United Electric Tramways Power Station, 74, High-road, Chiswick, between the hours of 10 a.m. and 4 p.m. on any weekday, except Saturdays, from 1st to 11th January, 1924, both dates inclusive, by appointment with a representative of the London County Council.
Particulars and form of Tender may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C. 2.
No Tender will be considered if received at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 14th January, 1924.
The Council does not bind itself to accept the highest or any Tender.
JAMES BIRD,
4431 Clerk of the London County Council.

State Electricity Commission OF VICTORIA.
MELBOURNE, VICTORIA, AUSTRALIA.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION NO. 24/4.—4 ONLY
100 K.V.A., 25,400-6600 V. TRANSFORMERS AND SPARES.
CHARGE.—10s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £10 is to be lodged with Tender.
The specification may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 11th February, 1924.
R. LIDDELOW,
4391 Secretary.

PUBLIC NOTICES

Clyde Navigation.
DOCK NO. 1, SHIELDHALL, GLASGOW HARBOUR.
The Trustees of the Clyde Navigation invite TENDERS for the CONSTRUCTION of about 1928 LINEAL YARDS of CONCRETE QUAY WALL forming Dock No. 1, Shieldhall, Glasgow Harbour, to be founded partly on a substructure of concrete monoliths and partly in open piled trench.
The specification and schedule and form of Tender can be obtained at the Engineer's office here on and after Friday, 4th January, on payment of a deposit of £10, which will be returned on receipt of a bona fide Tender.
An assistant engineer will meet intending officers on Monday, 7th January, at 11 a.m., at Maxwell-road, Shieldhall, to point out the situation of the works, and subsequently as may be required.
Sealed Tenders, marked "Tender for Dock No. 1, Shieldhall," are to be lodged with the undersigned not later than Noon of Monday, 28th January next.
The lowest or any Tender may not be accepted.
T. R. MACKENZIE,
General Manager and Secretary.
16, Robertson-street, Glasgow,
28th December, 1923. 4442

Great Northern Railway (Ireland).
The Directors are prepared to receive TENDERS for SUPPLY of:—
FIVE 50-ft. PASSENGER CARRIAGES.
Copies of the specification, drawings, and form of Tender may be obtained from the undersigned on payment of One Guinea, which will be refunded on receipt of a bona fide Tender and return of the drawings.
Tenders, made out on the forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Passenger Coaches," not later than 10 a.m. on Tuesday, 15th January, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station,
Dublin, 22nd December, 1923. 4432

Keighley Corporation.
BLADEN VALLEY WATERWORKS.
CONTRACT G.
IRONWORK FOR VALVE WELL, FILTER BEDS, &c.
The Corporation invite TENDERS for the MANUFACTURE of STEEL MANHOLE DOORS, WROUGHT IRON LADDERS, CAST IRON COVER PLATES, STRAINER GUIDE COLUMNS, GIRDERS, and other Work required in connection with the Construction of the Valve Well, Filter Beds, and Straining Well, &c., for the Lower Laithe Reservoir Works.
Copies of specification and schedule of prices and a limited number of copies of the drawings (to be returned within seven days) may be obtained from the Engineer, Mr. M. Ratcliffe Barnett, M. Inst. C.E., Town Hall, Keighley, on and after Monday, December 31st, 1923.
Sealed Tenders, endorsed "Keighley Waterworks, Lower Laithe Reservoir, Contract G," addressed to the Chairman of the Waterworks Committee, must be delivered to the undersigned on or before the 16th of February, 1924.
The Corporation do not bind themselves to accept the lowest or any Tender.
SMITH TERRY,
Town Clerk.
Town Hall, Keighley,
December 22nd, 1923. 4440

SITUATIONS OPEN

WANTED, POWER STATION SUPERINTENDENT for North Midlands, age under 40. Thorough experience Stirling Boilers and Turbo-generators. No testimonials with application. Salary £360.—Address, 4381, The Engineer Office. 4381 A

PUBLIC NOTICES

County Council of Surrey.
HIGHWAYS AND BRIDGES DEPARTMENT.
APPLICATIONS are INVITED for the APPOINTMENT of a SECOND ENGINEERING ASSISTANT at a salary of £250 per annum. Candidates must have had experience in surveying, levelling, preparation of drawings, and specifications for road and bridge construction, and shall have passed the examination qualifying for Associate Membership of the Institution of Civil Engineers or hold the Testamur of the Institution of Municipal and County Engineers. Age not to exceed 40.
The appointment will be to the temporary staff and will not be subject to the provisions of the Local Government Officers' Superannuation Act, 1922.
Applications, in candidates' own handwriting, accompanied by copies of three recent testimonials, should reach the undersigned by the 9th January, 1924.
W. P. ROBINSON, A.M. Inst. C.E.,
County Surveyor.
County Hall, Kingston-on-Thames,
21st December, 1923. 4427

State Railways of Victoria, AUSTRALIA.
ASSISTANT CHIEF ELECTRICAL ENGINEER.
APPLICATIONS are INVITED by the Victorian Railways Commissioners for the above POSITION.
Salary £1000 per annum.
Applicants must pass medical examination.
Applicants must be capable of successfully handling all engineering and operating matters connected with railways, electrified systems, preparing proposals, alterations and extensions; also erection and maintenance of electric power and lighting installations throughout railways.
Applicants should give full name, age, place of birth, details of engineering and administrative qualifications and practical experience on electrical railways with copies of references.
Applications, in sealed envelopes, marked "Application for Position Assistant Chief Electrical Engineer," should be addressed to the Secretary, Victorian State Railways, Melbourne, Australia, direct, and must reach him on or before 31st March, 1924.
On behalf of the Victorian Railways Commissioners,
JOHN McWHAE,
Agent-General for Victoria (Australia),
Victoria House, Melbourne-place,
4420 Strand, London, W.C. 2.

SITUATIONS OPEN (continued)

WANTED, ENGINEER for Foreign Sales Department; well educated, good practical and technical training, also selling experience; French and commercial experience abroad essential.—Apply, giving full particulars of age, experience and salary required, to HANS RENOLD, Ltd., Burnage Works, Didsbury, Manchester. 4423 A

FACTORY ENGINEER REQD., Portugal. Exp. modern Steam and D.C. Plant; also Textile Machinery Upkeep and Repairs exs. Aged 29/45. Portuguese language if possible. House provided.—Apply LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 4429 A

HEAD RATE FITTER WANTED for Marine Engine Works, North-East Coast. Previous experience in similar work and knowledge of Marine Engine Works practice essential.—Address, giving full particulars, references, and salary, 4378, The Engineer Office. 4378 A

INDIA.—ENGINEER WANTED by an English Company in the Punjaub, with good all-round experience, Mechanical, Electrical, and Motor. Must be single and age not exceeding 35 years. Pay Rs. 350 per month, rising Rs. 25 annually, with free quarters; five years' agreement. Free passage out and home.—Write, stating qualifications and full details experience, to G. B., c/o Crossley and Co., Ltd., 5, Racquet-court, Fleet-street, London, E.C. 4. 4417 A

SITUATIONS OPEN (continued)

OLD-ESTABLISHED FIRM of CRANE MAKERS are prepared to receive APPLICATIONS for the POST of DESIGNER MANAGER. Practical experience essential, mechanical and electrical, also must have commercial experience. State age, references, and salary required.—Address, 4404, The Engineer Office. 4404 A

PUBLICITY.—WANTED by Large Engineering Firm in the Midlands, MAN with technical knowledge and experience in Publicity Work, preferably with some experience in Journalism. Permanent position, with prospects.—Address, giving full particulars of education, training and experience, 4428, The Engineer Office. 4428 A

WORKS SUPERINTENDENT REQUIRED by Engineers in Midlands employing 300 hands, manufacturing Sluice Valves, Water Meters, Plumbers' Brasswork, &c.
Must be experienced in Modern Shop Practice and Mass Production Methods, and be accustomed to Controlling Men, Fixing Lay-out of Machine Tools, &c.
Salary £400.—Address, in confidence, with full particulars of age and experience, 4424, The Engineer Office. 4424 A

WANTED, Capable DRAUGHTSMAN, Accustomed to High-pressure Hydraulic Work.—Apply by letter, stating age, experience, and wage required, to THE HYDRAULIC ENGINEERING CO., Ltd., Chester. 4382 A

WANTED, TWO DRAUGHTSMEN, London Area, accustomed to Lay-outs, Pipework, &c. Also ONE DRAUGHTSMAN with Electrical Experience, accustomed to Station Work.—Address, stating full particulars, age, past experience and salary required, together with copies of references, 4425, The Engineer Office. 4425 A

FIRST-CLASS STRUCTURAL DRAUGHTSMEN REQUIRED; none but experienced men need apply. State full particulars, age, salary required.—THE CLEVELAND BRIDGE and ENGINEERING CO., Ltd., Darlington. 4076 A

JUNIOR DRAUGHTSMAN REQUIRED, East Midlands, with experience of Pumping Machinery. State age, experience and salary.—Address, 4435, The Engineer Office. 4435 A

MECHANICAL ENGINEERS and Public Works Contractors REQUIRE DRAUGHTSMAN to Take Particulars and Prepare Drawings of Outside Work. State salary required, with age and experience.—Address, 4434, The Engineer Office. 4434 A

STRUCTURAL DRAUGHTSMAN.—DETAILER REQUIRED for London Steel-framed Buildings AT ONCE.—Address, P3452, The Engineer Office. P3452 A

FOREMAN REQD., S.W. London. Exp. Wireless Switchboard Manufacture and Assembly mss Aged 29/36. 4912.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 4430 B

SITUATIONS WANTED

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ENGINEER (32), 1st B.O.T., Ex Chief Engineer, wide experience all class engine and boiler repairs, moderate salary, excellent references, REQUIRES POST as WORKING ENGINEER or MECHANIC.
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ENGINEER (45), M.I.M.E., M.I. and S.I., thoroughly practical and commercial, of proved ability, 18 years' administrative experience with railway rolling stock, motor vehicles, and power plants, DESIRES POSITION as GENERAL MANAGER, REPRESENTATIVE, or similar. London district preferred. Salary £500 to £750.—Address, P3391, The Engineer Office. P3391 B

ENGINEERS' ASSIST. or DRAUGHTSMAN (35), mechanical, constructional and general maintenance, buildings, general superintendence and plant lay-out. Last 5 years with large London flour mill.—Address, P3456, The Engineer Office. P3456 B

MARINE ENGINEER (38) DESIRES SHORE APPOINTMENT; chief's certificate, excellent references, some commercial experience; anything considered.—Address, P3446, The Engineer Office. P3446 B

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SITUATIONS WANTED (continued)

OIL ENGINES, Cold Starting, Hot Bulb, or Motor Car Types.—ENGINEER, specialised in the above, will DESIGN to suit manufacturers or patentees. Advice freely given. Highest qualifications. Results guaranteed.—Address, P8454, The Engineer Office. P8454 B

SALES ENGINEER, Young, Experienced, at Liberty early New Year, SEEKS OPENING with reputable firm.—Address, P8415, The Engineer Office. P8415 B

UNIVERSITY GRADUATE, B.Sc. (C.E.), with Two years' experience in light railways, roads, sewers, surveying, and metal mining, DESIRES POST or offers service with remuneration for experience in any other civil branch.—Address, P8450, The Engineer Office. P8450 B

WORKS.—BUILDING ASSISTANT to Chief Engineer DESIRES POST. Capable architect and surveyor, take control of new, alteration and maintenance work, able to organise works building dept. or control outside contractors, measure up, check accounts, extras and variations, write specifications, estimate, allocate costs, survey and supervise construction.—Address, P8410, The Engineer Office P8410 B

YOUNG ENGINEER DESIRES POSITION Abroad. Present moment acting as English representative at a factory in Belgium.—Address, P8448, The Engineer Office. P8448 B

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MISCELLANEOUS

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PATENTS

THE PROPRIETOR of BRITISH PATENTS Nos. 145,562 and 139,551, both dated January 10 1919, relating to "Improvements in Machine for Forming Hairpins or Similar Articles," and "Improvements in Machine for Counting and Arranging Hairpins or like Forked Articles," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCES or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to B. SINGER, Steger Building, Chicago, Ill. 4377 E

MACHINERY, &c., WANTED

MOTOR WAGON WEIGHBRIDGE WANTED, in first-class condition. Please state maker's name, full particulars, lowest price.—Address, 4422, The Engineer Office. 4422 F

ROLLS, Second-hand, WANTED, 10 to 12ft., for bending boiler plates up to 1¼in. thick, to open at one end.—Address, 4421, The Engineer Office. 4421 F

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For Sale Adverts. continued on page 90.

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Rebuilding the Menai Bridge.

IN the Journal of October 19th, we referred to the possibility that the reconstruction of Telford's celebrated suspension bridge across the Menai Straits might be included in the Government's programme of bridge work devised in relief of unemployment. It is now stated that the Carnarvonshire County Council has been informed that it is the Government's intention to erect a reinforced concrete bridge across the Straits in place of the existing suspension bridge, the safety of which has for some time past been a matter of some doubt. The Carnarvonshire and Anglesey County Councils are expected to bear half the cost of maintaining the bridge after erection. The bridge, it is specified, must be toll free.

Railway Locomotive Contracts.

THE fear expressed by some that of the large sums of money to be expended by the railway companies on new works and equipment, the whole, or the bulk, of those portions intended for new locomotive construction would be expended in the railway companies' own locomotive building works, does not appear to have been well founded. It is announced that the London, Midland and Scottish Company has placed orders for fifty six-coupled tank engines with the private builders, namely, for twenty with the Vulcan Foundry and for fifteen each with the Hunslet Engine Company and the North British Locomotive Company. The London and North-Eastern Company's locomotive building programme provides for the addition of 273 engines, to the company's equipment, at a total cost of £1,270,000. Of these engines, 104 are to be built in the company's own shops, and 125 are to be purchased from the Government. The remaining 44 are to be built by private firms. The North British Locomotive Company is to build twenty express passenger "Pacific" type engines, Armstrong, Whitworth and Co. are to supply twelve 4–4–0 express passenger engines, and Kitson and Co. are to build an equal number of similar engines. The 125 locomotives to be acquired from the Government are mineral engines of the Great Central type.

Railway Rolling Stock Orders.

IN addition to the orders for locomotives mentioned in the previous paragraph, the carriage and wagon building programme for 1924 of the London and North-Eastern Railway involves an expenditure of nearly five and a-half millions. It includes the construction of four new complete trains for the day services between King's Cross and Edinburgh, on which, as in the London–Leeds service, meals will be cooked wholly by electricity. All coaches will have Pullman vestibules, as experience, extending over some years, has shown that this type is of great service in the event of a mishap. Two new complete trains are to be built for the Liverpool-street–Harwich continental service. The total number of passenger vehicles to be built is over 700, of which 414 are to be constructed in the company's various shops. Two hundred and ninety new coaches are to be built for the London suburban services. They will be an improvement on those now in use, being steam-heated and electrically lighted. They are to be built by contract. The number of wagons to be built is 12,000, involving an expenditure of £2,400,000. Most of these vehicles will be built in the company's own shops, 80 brake vans and 300 goods brakes being contracted for.

Port of Tangiers.

THE signing of the Statute of Tangiers has reopened the question of the concession for the construction of the port, which appears likely to be settled under much more satisfactory conditions than when a previous concession was granted to a French company two and a-half years ago. As soon as the French Protectorate over Morocco was confirmed after the Armistice, the French Government argued that the Sultan held sovereignty over Tangiers, and that consequently he was perfectly free to do as he pleased, and as his pleasure coincided with the dictates of his protectors, there could be no doubt as to the future course of his policy. On granting a concession to a French company under conditions which gave it complete control over the port, the Sultan, at the behest of the French Government, challenged the international character of the administration of Tangiers, but the vigorous protests of the British, American, Spanish and other Governments left France no alternative but to suspend the concession until a settlement was come to concerning the future status of the town. Under the Statute, which has now been signed, the Sultan is recognised as having the right to grant a concession for the construction and control of the port to the Société Marocaine des Travaux Publics, but the contract for the construction can only be given out with the approval of a commission on which the Powers, as well as the Sultan and the municipality of Tangiers, will be represented. This arrangement means probably that the work will have to be submitted to tender, so that contractors in different countries may be given an opportunity to compete for it. An immediate result of the settlement will be the pushing forward of the railway from Fey to Tangiers, that is destined to play an important part in the commercial development of Morocco. It is fully expected in France that, with the construction of the port, Tangiers will offer unique advantages for maritime transport, and the carrying out of the undertaking will mark the beginning of a rapid development of the new Protectorate.

The British Association.

ACTIVE preparations are now being made in Toronto and London for the meeting of the British Association in the first-named city next year. The date of the meeting, provisionally announced as September 3rd to 10th, has been altered to August 6th to 13th, and the official excursions will follow and not precede the meeting, as originally intended. Sir David Bruce, the well-known authority on tropical medicine, will preside over the gathering. The visit to Canada will afford British scientists an opportunity for intercourse with their American brethren. A meeting of the American Association for the Advancement of Science is to be held in Buffalo immediately before the British Association assembles at Toronto, and arrangements are being made whereby members of either body will be admitted to the meetings of the other. The Association will meet at Southampton in 1925 and probably at Oxford in 1926.

Repairing Canadian Pacific Liners.

A NEW arrangement, we understand, has been made for the repair of the Canadian Pacific liners sailing from the Mersey. A few years ago the Canadian Pacific Ocean Services took over the Bootle engine works of the Allan Line, and now that establishment has been acquired by William Beardmore and Co., Limited, of Glasgow. The Clyde firm will use the works as a special repairing department, and from it will undertake the repair and maintenance of the Canadian Pacific liners based on Liverpool. It is understood that Messrs. Beardmore will also undertake general ship-repairing and engineering work on the Mersey. The works under the new management will, it is expected, be opened on January 1st, 1924, and will be under the management of Mr. S. C. Oldham and Mr. C. R. Smith, both of whom are well known in ship-repairing circles on the Mersey. Mr. Oldham has occupied important posts with Cammel Laird and Co., and with Clover, Clayton and Co. Mr. Smith has for many years been closely associated with H. and C. Grayson, of Garston, Liverpool.

Two Railway Accidents.

LAST week a serious accident occurred on the London and North-Eastern Railway at South Gosforth, near Newcastle. At the site of the accident the company has recently completed three large sheds for the accommodation of electric cars used in the service between Newcastle and the coast. A loop from these sheds leads to the coast line. On Tuesday week, December 18th, a train of electric cars left this shed early in the morning to take its place in the morning service. Whilst it was still on the crossing a mineral train from Ashington going towards Newcastle drove right into the electric cars cutting the train in two. The collision took place on a bridge which crosses the Gosforth and Benton road at this point, and the heavy mineral locomotive being derailed by the impact, overthrew the parapet of this bridge and fell on to the road below. The fireman was instantly killed and the driver died a few hours later. Fortunately, there was no one in the electric train, save the driver and the guard, neither of whom was seriously hurt. On the same day the 9.50 train from St. Pancras met with an accident when near Bedford. The speeds on that section are very high, and when the train was making something like 70 miles per hour, one of the connecting-rods and a flange of one of the engine wheels broke. The engine travelled for nearly a mile before it could be pulled up. No one was seriously injured.

Instruction of Oil Fuel Stokers.

AT the annual meeting of the P. and O. Company recently Lord Inchcape expressed the thanks of that company to the White Star Company for permitting engineers and their assistants to gain experience with the working of the oil-burning furnaces on the White Star liners Majestic and Olympic. This mutual exchange of experience is highly gratifying, and should help to increase the efficient working of British liners and steamships. In America the same problem has been presented, and we learn that a contribution to its solution has been made by the Todd Shipbuilding Corporation, of New York, which has instituted a practical and theoretical course of free instruction in the handling of its oil fuel burning equipment. The first course was begun in August with 12 men, and up to the present time some 180 men have applied to take up the course, out of which number, 139 have been granted certificates of proficiency. The course, we are given to understand, occupies about a week, and includes the actual demonstration and handling of a full boiler-room equipment. Practical work is supplemented by lectures on combustion, atomisation and the properties of fuel oils, and at the end of the time a practical examination is held in the boiler-room. The certificate of proficiency is granted when the student shows that he is thoroughly acquainted with the system. As far as we are aware, there are few opportunities to gain similar knowledge in this country—outside the ships—and the idea may well be worth the consideration of British firms manufacturing this class of apparatus.

The Diesel Engine Users' Association.

THE success of the Diesel Engine Users' Association is in no small measure due to the enthusiasm and initiative of its honorary secretary, Mr. Percy Still. It is nearly ten years ago since Mr. Still, together with other central station engineers using Diesel engines for generating electric current, conceived the idea of furthering the interests of such users of internal combustion engines by collecting and circulating information on various points arising in connection with the working of these engines. The object of the Association has been fully realised, and its work has been highly beneficial alike to engine manufacturer and user. It was with regret therefore that we learned of the impending retirement of Mr. Still after his long term of office, but we are now able to state that arrangements have been made whereby Mr. Still will be relieved of some part of his duties by the appointment of Mr. Percy Still and Mr. Geoffrey Porter as joint honorary secretaries. Mr. A. W. A. Chivers, of the British Electrical Federation, Limited, has been elected President of the Diesel Engine Users' Association for the year beginning January 1st, 1924.

An Atlantic Airship Service.

WHILE the Burney scheme for the establishment of an airship service between this country and India, with, eventually, an extension to Australia, is still under the consideration of the Government, news is to hand that a Transatlantic airship service is also being contemplated. Speaking at New York, the Duke of Sutherland, the Under-Secretary for Air, is reported to have stated that by next July a limited airship service for passengers and mails would probably be in operation between Great Britain and Canada. The Zeppelin passenger airship constructed at Friedrichshaven for surrender to the United States Government, which we described in our issue of December 7th, will, it is intended, be flown across the Atlantic to its destination; but it is not proposed, so far as we are aware, to employ the vessel on such a service as a regular proceeding. We understand that the intention is to use this airship for passenger and mail services within the boundaries of the United States.

Purchase of an Engineering Works.

THE engineering works of E. G. Wrigley and Co., Limited, together with the plant, machinery and goodwill, have, it is announced, been sold by the receiver for the debenture holders to Mr. W. R. Morris, of Oxford, the well-known light car manufacturer. Messrs. Wrigley's works at Soho, Birmingham, were equipped for the production of engineers' small tools and of transmission gearing for the motor car industry. After the Armistice, they were reorganised and laid out mainly for the large-scale production of transmission gearing for the Angus-Sanderson car. The plans, however, fell short of fulfilment, adverse conditions being encountered, and in 1920 the profit and loss account showed a debit balance of £67,000 odd. A year later the ordinary shares were written off from 20s. to 12s., but in the balance sheet presented last July a debit balance of £96,000 odd was disclosed. As a result of the sale it is expected that the number of persons employed at the works—in recent times between 400 and 500—will be largely increased. The purchase price is stated to be £200,000.

Sir William Forbes.

AFTER fifty years of railway service Sir William Forbes has retired from active work. He was born at Dublin in 1856. Choosing the same career as his father, who was general manager to the Midland and Great Western Railway of Ireland, he joined the London, Chatham and Dover Railway, and under the care of his uncle, who was general manager of this company, he received a thorough training in many of its departments. In 1889 he was appointed continental manager and subsequently was made traffic manager. When the company entered into a working arrangement with the South-Eastern Railway in 1898, he was given the position of assistant general manager of the amalgamation. In October, 1899, he was appointed general manager of the London, Brighton and South Coast Railway, a post which he has since held. He received the honour of knighthood in 1915, and throughout the whole of the war period played a conspicuous part in the heavy and important transport and other work which his company was called upon to perform.

Some British Locomotive Performances.

By J. T. BURTON-ALEXANDER.

PERHAPS it may be of interest to publish some runs on British railways, which date back to about twenty years ago. The loads were less, much less, but I have tried to give only those that were remarkable by the freedom in running and whole-hearted endeavour to make up time and fight against signal or other delays. In many cases the engines are no longer running, but have long since been scrapped.

MIDLAND.

On the Midland in July, 1901, on the up Aberdeen and Edinburgh night express from Leeds, Engine 2607, a Belpaire, Driver Ward, and a load of 5 = 9 or 121 tons, in spite of a rainy morning, from Leeds we passed Normanton, 11 miles, in 12 min. 20 sec. at reduced speed; Cudworth, 21 miles, in 23 min. 20 sec., in spite of P.W. slacks near Sandal; Rotherham, 34 miles, in 36 min. 45 sec., in spite of a slow before Kilnhurst; and Chesterfield, 50 miles, in 54 min., dead slow for the Junction, Doe Hill, 57¼ miles, in 63 min. 25 sec., in spite of a bad P.W. slack; and stopped at Trent Junction, 76¼ miles, in 83 min. 25 sec., after being slowed at Toton, or a net time of 78 min. From Trent we had rain and a side gale, and from Irchester we had dreadful signal delays. However, from passing that station at 20 m.p.h., we had accelerated at the top of the bank to 45 m.p.h.; and from a slow at Bedford, Kempston-road box, in 1½ miles, had reached 53 m.p.h.

In 1902, with a Manchester Express No. 1860—a single—and a load of six coaches, 150 tons, from Leicester, we passed Wigston Junction, 3¾ miles, in 5 min. 25 sec.; Market Harborough, 16 miles, in 18 min. 53 sec.; Kettering, 27 miles, in 30 min. 30 sec., with a minimum of 42 m.p.h. up to Desborough; Wellingborough, 34 miles, in 36 min. 10 sec.; Bedford, 49½ miles, in 51 min., the minimum speed being again 42 m.p.h. from Irchester; Luton, 69 miles, in 73 min. 25 sec.; St. Albans, 79¼ miles, in 83 min. 13 sec.; Hendon, 92¼ miles, in 94 min. 43 sec.; and after slows at West End, Haverstock Hill, and before St. Pancras, stopped in that station, 99¼ miles from the start, in 104 min. 5 sec., or 102 min. net; but we had converted a late departure of 1 min. 55 sec. into an early arrival of no less than 7 minutes.

In 1904 on a 105 min. Express from Leicester to London, Engine 1857, Driver Cole, a single, with a load of six coaches, 170 tons, we passed Wigston in 6 min. 45 sec.; Market Harborough, in 19 min. 35 sec.; Kettering, in 30 min. 20 sec., the minimum speed being no less than 48 m.p.h. to Desborough; Wellingborough in 35 min. 45 sec., with a maximum of 86.5 m.p.h.; Bedford, in 50 min. 33 sec., our minimum up Irchester being 45.9, and our maximum 80.3, with a check over the water troughs at Oakley; Luton, in 72 min. 03 sec., the engine having been eased to a minimum of 50 m.p.h., up the long bank; St. Albans, in 83 min. 58 sec., which was passed at only 48 m.p.h., owing to signals slows at Harpenden and Sandridge box; Hendon, in 96 min.; and we stopped in St. Pancras in 104 min. 15 sec., after a slack at Haverstock Hill; our net time was 100 min. 45 sec., and from platform end to platform end, 100 min. net.

GREAT NORTHERN.

On the Great Northern, in 1901, with No. 266, an Ivatt single and a load of seven coaches, or 180 tons, from Grantham, on a Leeds Express, we passed Barkston, 4¾ miles, in 6 min. 53 sec.; Newark, 14¼ miles, in 15 min. 47 sec., our speed having risen to 75 m.p.h.; Retford, 33¼ miles, slacked, in 34 min. 15 sec., with a minimum of 52 m.p.h.; Bawtry, 42½ miles, in 43 min. 48 sec.; and stopped in Doncaster 50½ miles, in 52 min. 40 sec., the engine having been eased after Retford, having gained 2 min. 20 sec. on schedule.

In 1902, with the 1.30 Leeds Express and Locomotive 1003, an 8ft. single, and a load of nine coaches or 210 tons, we passed Finsbury Park, 2¼ miles, in 5 min. 10 sec.; New Southgate, 6¼ miles, in 10 min. 7 sec.; Potter's Bar, 12¾ miles, in 18 min. 30 sec.; Hatfield, 17¾ miles, in 23 min. 55 sec; Hitchen, 32 miles, in 38 min. 50 sec.; Sandy, 44 miles, in 49 min. 25 sec.; St. Neots, 51¼ miles, in 57 min. 10 sec.; Huntingdon, 58¾ miles, in 64 min.; Abbotts Ripton, 63¼ miles, in 69 min. 21 sec.; and stopped in Peterborough, 76¼ miles, in 82 min. 25 sec., 35 sec. early; at Wood Green our speed had risen to 53 m.p.h., and at Potter's Bar had fallen to 42.8, by Knebworth it was 48.9, and at Three Counties 73.7 m.p.h., and up the 1 in 200 to Abbotts Ripton, 48.4. Fine work for the load, but were we pushed out of King's Cross?

The same year on the 2 p.m. Special Leeds Express, owing to an engine failure from leaky tubes, an old goods engine, No. 460, with a load of 5 coaches, 130 tons, from Newark, passed Claypole, 4¾ miles, in 7 min. 5 sec., at 50 m.p.h.; Hougham, 8¼ miles, in 11 min. 50 sec., at 48 m.p.h.; Barkstone, 10¼ miles, in 14 min. 25 sec.; and stopped at Grantham, 14¾ miles, in 20 min. 50 sec., speed at the summit being exactly 40 m.p.h. From Grantham we had Engine No. 1008, a Stirling single, Driver Noakes, and the same load. We passed Stoke summit, 5.4 miles, in 7 min. 32 sec., our speed having risen to 52.9; Little Bytham, 13 miles, in 14 min. 8 sec., at a speed of 83.3; Peterborough, 29 miles, in 27 min. 45 sec., dead slow as usual; Abbotts Ripton, 41¾ miles, in 41 min. 30 sec.; Huntingdon, 46¼ miles, in 48 min. 5 sec., in spite of a dead slow at Stukeley box; Sandy, 61¼ miles, in 61 min. 50 sec.; Biggleswade, 64¼ miles, in 64 min. 35 sec.; Hitchin, 73¼ miles, in 75 min., after another slow, just after Biggleswade; Hatfield, 87¼ miles, in 89 min. 15 sec.; Potter's Bar, 92¼ miles, in 94 min.; Finsbury Park, 102¾ miles, in 103 min. 45 sec., dead slow; and stopped in King's Cross, 105¼ miles, in 108 min. 10 sec. gross, or 102 min. net. By Yaxley, 3½ miles from Peterborough, we were doing 60 m.p.h.; Abbotts Ripton bank was begun at 69.2, and finished at 60, mostly at 64; at Tempsford we were doing 72; Sandy, 64.2; Hitchen, 56; Knebworth, 56.9; Hatfield, 66.9; and breasted Potter's Bar at 64.2 m.p.h.

SOUTH-WESTERN.

The same year on the London and South-Western Railway, with Engines Nos. 651 and 659, both Adams, and a load of eight bogies, 200 tons, from Salisbury, we passed Wilton, 2¼ miles, in 5 min. 10 sec.; Templecombe, 28½ miles, in 32 min. 15 sec., in spite of a long signal slow, our speed at Semley being exactly 50 m.p.h.; Sherborne, 34½ miles, in 41 min.; Crewkerne, 48 miles, in 55 min. 35 sec., our speed at the summit being 21.8; Chard Junction, 56 miles, in 64 min. 20 sec.; Seaton Junction, 64¼ miles, in 72 min. 8 sec.; Honiton, 71¼ miles, in 83 min. 22 sec., our minimum speed being 32 m.p.h.; Sidmouth Junction, 75¾ miles, in 87 min. 30 sec., our speed having reached 75 m.p.h. on the descent; Exeter, 88 miles, was reached in 101 min. 30 sec., in spite of a slack, or 98 min. net.

From Devonport to Exeter, St. David's, Engine 659, with a load of five bogies or 125 tons, passed Tamerton, 4¾ miles, in 7 min. 5 sec., having attained 61 m.p.h.; Bere Alston, 9¼ miles, in 14 min. 30 sec., our speed not having gone below 30 m.p.h.; Tavistock, 16 miles, in 24 min. 22 sec.; Lydford, 22¼ miles, in 31 min. 50 sec., our speed up the 1 in 70 being 31.6 m.p.h.; Okehampton, 32¼ miles, in 44 min. 22 sec., up the 1 in 75 our minimum being 41 m.p.h.; Yeoford Junction, 46¾ miles, in 61 min. 10 sec., in spite of a long relaying slow before North Tawton, but we attained 75 m.p.h., and stopped in Exeter, St. David's, 57¼ miles, in 72 min. 10 sec. gross, or 68 min. net.

From Queen-street to Salisbury, we had a load of eight coaches, 190 tons, and Engine 117, an early Drummond, without water tubes, and passed Sidmouth Junction in 17 min. 38 sec., Honiton in 24 min. 6 sec., our minimum speed being 39.1 m.p.h. up the 1 in 100, and 30.4 up the 1 in 80; Seaton Junction in 32 min. 25 sec., the speed having reached 83.3 m.p.h.; Chard Junction in 42 min. 55 sec., Yeovil Junction in 60 min. 25 sec., Sherborne Junction in 66 min. 5 sec., Templecombe in 74 min. 45 sec., our speed up the 1 in 80 being 30.3 m.p.h.; Semley in 87 min., our speed being 34 m.p.h., and stopped in Salisbury in 105 min. 40 sec., after a slow in from signals, leaving a net time of 104 min. 40 sec.

N.E.R.

On the North-Eastern Railway in 1902 behind Engine 1869 (7ft. 7in. four-coupled) and a load of seven coaches, or 143 tons, from Darlington we passed Eyreholme in 6 min. 57 sec., Northallerton in 15 min., Thirsk in 21 min. 45 sec., Pilmoor in 27 min. 2 sec. Tollerton in 32 min. 20 sec., and stopped in York Station in 42 min. 35 sec., in spite of a signal slow outside, or 41 min. net, platform end to platform end, taking 39 min. 27 sec. net. Our maximum speed was 75 m.p.h.

L.C. AND D.R.

On the London, Chatham and Dover Railway, Engine 478, an old Kirtley, with the second portion of a boat train, four coaches, or 75 tons, from Herne Hill passed Beckenham Junction in 9 min. 35 sec. with dead slows at Dulwich and Sydenham Hill, Bickley Junction in 13 min. 35 sec., dead slow and at Bromley as well; Sole-street in 34 min. 30 sec., again slow and two slows at St. Mary Cray; Chatham in 46 min., with a signal slow down the bank and at Rochester Bridge; Sittingbourne in 59 min. 35 sec., with a slow at Rainham and Queenborough Junction; Faversham in 66 min. 50 sec., Canterbury in 83 min., after a stop at Selling; Shepherds Well in 96 min. 25 sec., after a slow at Adisham, and stopped on Dover Pier in 103 min. 25 sec. gross, only 3 min. 25 sec. over booked time, or not more than 82 min. 30 sec. net, a fine effort even for so light a load.

L. AND N.W.

On the London and North-Western Railway, in July, 1911, I had a rather remarkable run on one of the two hours Birmingham Expresses, behind Engine No. 1059, a superheated "Precursor," and a load of ten coaches, or 330 tons. As far as Tring the running was not so wonderful, owing to the fire being not properly burnt through, but the remainder of the journey more than made up for it. Starting from Euston we passed Chalk Farm, 1¼ miles, in 5 min. 30 sec.; Willesden Junction, 5¼ miles, in 11 min. 50 sec.; Watford, 17¼ miles, in 25 min. 50 sec.; Tring, 31¾ miles, in 42 min. 10 sec.; Bletchley, 46¾ miles, in 54 min. 55 sec.; Roade, 59¾ miles, in 66 min. 30 sec.; Rugby, slow, 82¾ miles, in 86 min. 40 sec.; Coventry, 94 miles, in 97 min. 35 sec., and stopped in Birmingham, 113 miles, in 116 min. 45 sec., 2¼ min. early, having taken only 74 min. 15 sec. for the 81¼ miles from Tring to New-street Station.

G.W.R.

On the Great Western I have had, since 1900, some magnificent work. In 1901, on the 10.35 Cornishman, with a load of nine Eights, Engine 3380, "Ladysmith," driver Morgan, in spite of a furious side gale, passed Southall in 13 min. 13 sec., slowed to 30 m.p.h., and again for relaying just beyond; Slough in 24 min. 22 sec., Reading in 42 min. 30 sec., Didcot in 59 min. 7 sec., our speed at Cholsey having risen to 68.1 m.p.h.; Swindon in 84 min. 45 sec., our lowest speed being 56.9 m.p.h.; Chippenham in 101 min., Bath, slow, in 113 min. 50 sec., our speed down Box having risen to 75 m.p.h.; Bristol East Junction in 125 min. 20 sec., Pyle Hill Junction in 129 min. 15 sec., Uphill Junction in 150 min. 32 sec., Bridgewater in 163 min. 30 sec., Taunton in 177 min. 5 sec., in spite of a P.W. slow before; Whiteball Box in 193 min. 40 sec., our minimum speed being 24.4 m.p.h., and stopped in Exeter in 213 min. 15 sec. gross, or 208 min. 15 sec. net, for 193.6 miles.

On the up Cornishman with a load of thirteen coaches, or 335 tons, and two "Camels," Nos. 3347 and 3348, from Par we passed Bodmin-road, 7¾ miles, in 13 min. 23 sec.; Doublebois, 13¼ miles, in 23 min. 23 sec.; Saltash, 30.5 miles, in 46 min. 5 sec., and stopped in Plymouth, North-road, 35½ miles in 58 min., after two stops outside, or 53 min. net. Out of Par, up the 1 in 63, our speed rose to 26 m.p.h., and up to Doublebois on the 1 in 58 it was never less than 30 m.p.h., Bodmin-road being passed at 40.9 m.p.h.

From North-road we had an "Atbara" and a "Camel," Nos. 3357 and 3306, andpassed Plympton. 4 miles, in 6 min. 5 sec.; Hemerdon Box, 6.7 miles, in 13 min. 14 sec.; Brent, 16¼ miles, in 25 min. 32 sec.; Totnes, 23¼ miles, in 33 min. 30 sec.; Dainton Box, 28 miles, in 39 min. 40 sec.; Newton Abbot, 32 miles, in 44 min. 32 sec., and stopped in Exeter, 52 miles, in 70 min. 20 sec. Our minimum speed up the 1 in 42 to Hemerdon was 10.8 m.p.h., and at Dainton never less than 30 m.p.h.

In September of 1901 it was my fortunate experience to make two runs on the 12.5 non-stop from Exeter with Aden, an "Atbara," No. 3395; driver, John Millard. The first was with a load of nine coaches, 240 tons. We passed Tiverton Junction in 19 min. 6 sec., our speed having risen to 58.8 m.p.h.; Whiteball Box in 25 min. 10 sec., our speed having varied between 63 m.p.h., and 52.3 with the final ¼ mile at 42.8 m.p.h.; Taunton in 33 min. 35 sec., our speed having risen to 89.1 with one-quarter at 90 m.p.h.; Uphill Junction, 55.8 miles, in 57 min. 30 sec., in spite of a P.W. slow at Durston, our speed being steady between 67 and 69.2 m.p.h.; Pyle Hill Junction, 75.2 miles, in 76 min. 50 sec.; Bristol East Junction, 76.6 miles, in 80 min. 10 sec.; Bath in 97 min. 50 sec., in spite of having been slowed before Tiverton, and stopped outside for 70 sec.; Chippenham in 114 min. 27 sec., our speed up the 1 in 100 to Box being 40.9 m.p.h.; Swindon in 130 min. 50 sec., our minimum up Wootton Basset being 52.3 m.p.h.; Didcot in 153 min. 55 sec., dead slow before; Reading in 177 min. 15 sec., after a long dead slow at Cholsey and avoiding stopping at every signal post at Reading; Slough in 194 min. 42 sec.; Southall, with a P.W. slow before, in 203 min. 45 sec.; Westbourne Park, with a slow before, in 213 min. 40 sec., and stopped in Paddington in 215 min. 30 sec., 1 min. before our booked time, and a net time of 195 min. for 193.6 miles.

On the seond occasion the load was only seven bogies, or 190 tons, and so far as I know is the fastest ever made by the old road by Bristol with a passenger train. We passed Tiverton Junction in 17 min. 45 sec., our speed having risen to 64.2 m.p.h.; Whiteball Box in 23 min. 5 sec., our lowest speed being 49.5 m.p.h.; Taunton in 31.45 sec., our maximum speed only being 84.9 m.p.h.; Uphill Junction in 57 min. 5 sec., in spite of the P.W. slow at Durston and at Highbridge; Pyle Hill Junction in 76 min. 50 sec., in spite of slows at Bedminster; Bristol East in 81 min. 5 sec., with a slow just after; Bath in 93 min. 10 sec., with a slow before and dead slow through the station for signals, just saving a stop; Chippenham in 110 min. 25 sec., with a slow before, our speed up Box being 40 m.p.h. exactly; Swindon in 126 min. 35 sec., our speed at Wootton Basset being 55.2 m.p.h.; Didcot in 147 min. 40 sec., our speed being a steady 72 m.p.h.; Reading in 162 min. 36 sec.; Slough in 178 min. 35 sec., at 69 m.p.h., after a slight check at Twyford; Southall in 187 min. 50 sec., with a long P.W. slow; Westbourne Park, slow as well, in 196 min. 25 sec., speed having risen to 66.7 m.p.h. before; and we stopped in Paddington in 199 min. 20 sec., in spite of another signal slow; our net time was only 184 min. 20 sec. We left Exeter 8 min. late and were in Paddington 10 min. early. From Swindon to Southall passed

slow and a check at Twyford, 68.2 miles, took 61 min. 15 sec.

In each case the regulator was wide open and the steam pressure was easily maintained; as the regulator had a tendency to shut itself, Millard had a string loop which was passed through the handle and kept it open.

In 1904 I had a run down with 102, a 4–4–2 compound to Bristol, and came back on the 4.45 from there with 3348, "City of Hereford," and a load of ten bogies about 270 tons. From Bristol we passed Ashley Hill in 6 min. 45 sec.; Filton in 10 min. 35 sec.; Chipping Sodbury in 20 min. 30 sec.; Wootton Basset in 43 min. 5 sec.; Swindon in 49 min. 30 sec.; Didcot in 73 min. 30 sec.; Reading in 90 min. 20 sec.; Slough in 111 min. 25 sec.; and stopped in Paddington in 130 min. 15 sec, with a slight slack at Twyford, losing 5 min. 15 sec. on booked time, but the brick arch came down at Badmington, and we only had 140 lb. of steam; it came down all over the fire, and I venture to think this run was a magnificent effort under these conditions, for we should have run in from Wootton Basset in under 75 min., making a net time of 118 min. or less.

THE RIVIERA EXPRESS.

This year, on July 27th, I was enabled, through the courtesy of Mr. Collett, to make a trip on the down Riviera Limited to Plymouth, which is of such a high standard that I am sure it, with an up run from Taunton, will be of great interest.

Owing to the holiday traffic, our load was no less than fourteen 70-footers of the newest stock, a tare load of 494 tons, or 535 tons full, as far as Westbury, and eleven 389 and 420 tons on to Plymouth, with every seat taken and people even in the corridors. Our engine was 4072 a super-heated four-cylinder 4–6–0, and the driver got every bit he could out of her, running magnificently. The weather was cloudy with a distinctly strong westerly wind, which, of course, told on a train of such a length. The firing was excellent, a single shovel at a time, the fire-box door being shut after each one, and the steam pressure never went below 215 lb. per square inch, with a full tube of water all the way. The coal was good and only once did the fireman use his irons when just before Newton Abbot he broke up the layer of clinker that had formed on the fire bars. Of course, towards Plymouth he raked his fire down. The fire was a thick one, practically level with the fire-box door, as is understandable for an engine doing such work. I confess when I saw the load and the engine standing under the bridge at the end of No. 1 Platform, at Paddington, I was doubtful as to time keeping, and the driver himself said sectional time would not be kept; that was not at all unnatural.

On a run like this, engine and crew have to be perfect. The running of the engine and her steadiness was wonderful. I should never have thought it was a 4–6–0, but, of course, the Great Western track is perfection, which must make for ease of traction. Owing to some person not having left the train, we were pulled up before clearing the platform, and will take that as the starting time as the engine was not far down the new relief platform at the stop.

I give the run in tabulated form :—

			h.	m.	s.
—	..	Paddington (dep. 10.30) ..	10	31	30
9	..	Southall	10	45	0
18¼	..	Slough	10	54	20
24¼	..	Maidenhead	10	59	45
36	..	Reading*	11	11	5
41¼	..	Theale	11	17	38
49¼	..	Thatcham	11	26	30
53	..	Newbury	11	30	25
61¼	..	Hungerford	11	39	58
70¼	..	Savernake	11	50	10
95¼	..	Westbury*	12	12	50
101¼	..	Frome*	12	20	30
111¼	..	Bruton	12	33	0
130	..	Langport East	12	48	20
143	..	Taunton	12	59	20
150	..	Wellington	1	6	30
153¼	..	Whiteball Box	1	11	50
158¼	..	Tiverton	1	16	45
173¼	..	Exeter* A (1.30)	1	30	40
185¼	..	Dawlish	1	44	5
193¼	..	Newton Abbot B (arr. 1.53) ..	1	52	45
		Due to pass, dep.	1	57	30
202¼	..	Totnes	2	10	45
209¼	..	Brent	2	21	40
217¼	..	Cornwood	2	30	35
221¼	..	Plympton	2	35	15
225¼	..	Plymouth, North-road (2.37)	2	40	30

* Service slows to 30 and 35 m.p.h. and 20 m.p.h. at Exeter.
A Signal slow at Stoke Cannon.
B Stop for Pilot 3543, 2–6–0.

On the down journey our speed had reached 45 m.p.h. before Ealing, 51.6 at Southall, 65.2 at Slough, not dropping below 63 at Maidenhead. The service slow at Reading was most carefully observed; at Theale our speed had risen again to 56.9 m.p.h., and rose to 57.6; at Kintbury it was 54.5, at Bedwyn 52.9, and at Savernake the final quarter was 39.1 m.p.h. Between Westbury and Frome it rose to 47.3, at Witham it was 44.7, and the summit before Bruton was breasted at 40.6 m.p.h. Over the descent to Taunton speed varied between 69.2 and a maximum of 81.8. Taunton was passed at 62.5 m.p.h.; at Wellington our speed was still 55.6 m.p.h., and before the tunnel we had only fallen to 42.5 m.p.h. Descending to Exeter we touched exactly 80 m.p.h. The run from Exeter to Newton Abbot was taken easily with careful observance of the speed reductions, and we stopped in Newton Abbot one-quarter of a minute early, having made up, including the signal slow at Stoke Cannon, 2 min. 50 sec.

It was natural to take a pilot from Newton Abbot with such a load, and our minimum speed up to Dainton was 21.7 m.p.h., and to Brent 25.7 m.p.h., rising before the top to 31.8 m.p.h. It was a pity the pilot had not been warned to be ready to take us on.

The regulator was wide open up the hills and on the level; in fact, after twenty-two years, I saw the same system of keeping it open as I had witnessed during the run on the Aden which is referred to above, and I confess this gave me a certainty of a good run. The reverse lever was cutting off at 27 per cent., and 25 per cent. to Reading, and from there to Aldermaston at 28 per cent., and 25 per cent. on to Savernake, being reduced to 18 per cent. down the banks. After Taunton it was at 30 per cent., before Wellington 35 per cent., and down to 40 per cent. for the 1 in 80 anticipating the loss in speed. This was the only point at which I saw the water in the gauge glass, which was a proof of the terrific demand on the boiler; but the proof of the pudding is in the eating, and we did the 10.9 miles from Taunton in 12 min. 30 sec. without the suspicion of a slip in the summit tunnel, so skilfully did the driver handle his sand. Up to Dainton the admission increased till it was no less than 55 per cent., and up to Brent 40 per cent.

Our net running time from London to Plymouth was 242 min. 15 sec., a gain of 4 min. 45 sec. on schedule—a wonderful effort with such a load. Truly, the "40's" are wonderful engines for hill-climbing, actual speed and weight pulling. The coal consumption did not strike me as excessive. Unfortunately, there was not a superheated steam gauge. It was a pleasure to find an engine where wire drawing was not necessary, and I think the run was one of the finest exhibitions of skill in driving I have seen.

On from Plymouth the load was ten bogies, taken unpiloted by a "29"—a two-cylinder 4–6–0. It is interesting to note that the Great Western is using 80in. wheels on its severe Devon and Cornish gradients, and, apparently, most satisfactorily. This bears out what I noted on the P.L.M. between Dijon and Pontarlier in 1914.

On the up run the engine was 4046, another four-cylinder 4–6–0, and the load ten bogies, 295 tons to Newbury, where one was slipped. The run was an example of perfectly easy running. In no case was the admission more than 20 per cent., and the steam pressure was steady at 225 lb. Bruton summit only reduced our speed to 45 m.p.h., and at Savernake our minimum speed was 58 m.p.h. The 143 miles to Paddington took 142 min. 30 sec. net. It was a fine performance all the same.

The following is a tabulated statement of the run :—

			h.	m.	s.
—	..	Taunton (dep. 6.28)	6	44	10
8	..	Athelney	6	54	10
17¼	..	Somerton	7	3	0
31¼	..	Bruton	7	15	45
41¼	..	Frome*	7	26	50
47¼	..	Westbury	7	34	10
56	..	Lavington	7	43	45
61¼	..	Patney	7	49	40
72¼	..	Savernake	8	0	20
90	..	Newbury A	8	15	45
107	..	Reading*	8	32	15
124¼	..	Slough	8	48	40
134	..	Southall	8	57	20
141¼	..	Westbourne Park B	9	4	20
143	..	Paddington (8.58)	9	7	30

* Service slows.
A Slip at Newbury.
B Signal check from Westbourne Park in.

I hope to have the pleasure of again trying the Riviera Limited, but next time through to Penzance, and with a load that will be unpiloted to Plymouth from Newton Abbot, but I dare not hope ever to find finer work than I noted, and must again congratulate Messrs. Churchward and Collet and the drivers.

ANOTHER RUN WITH THE CORNISH RIVIERA LIMITED EXPRESS.

WE had, recently, a further opportunity of travelling by the Riviera Limited, but with a lighter load than that recorded by Mr. Burton Alexander in the foregoing.

The train was made up of eleven 70ft. coaches and one 28-ton coach. The approximate weight was 422 tons without passengers. The train was not full. The locomotive was No. 4037, Queen Phillippa, 4–6–0 type. Even as the flag was waved the engine started to move, although she slipped slightly in getting away. Through Ealing the speed was 44 m.p.h., and at Southall we made 50 m.p.h., rising to 64 at Slough. Maidenhead was passed at 63 m.p.h., and at Reading, where we reduced speed to 30 m.p.h. for a service slack, we had taken 37 min. for the 36 miles. After passing Reading West our speed increased rapidly and we passed Theale at 57 m.p.h. and Thatcham, 8.25 miles further on, at 60 m.p.h. Newbury, 53 miles, was passed in 55.5 min., and we were making a steady 60 m.p.h. at the 56th and 57th mile posts. The next stretch of run to Savernake was done in 19.5 min. for the 17 miles, but the speed dropped to 40 m.p.h. at Savernake. Thence to Westbury, 25.5 miles, was run in 22 min., and the 78th mile post was passed at 69.2 m.p.h. and the 81st at 75 m.p.h. At Westbury a service slack was easily complied with, though we seemed to crawl round the curve. Our 95¼ miles had been completed in 97 min. dead, although we reduced speed considerably at the 85th mile post.

Leaving Westbury, we quickly picked up speed and passed Frome at 48.5, Witham at 46.5, and the summit, mile post 108.5 miles, at 41 m.p.h. At Alford Halt, 117 miles, we reduced speed considerably for permanent way repairs; Long Sutton was passed at 68 m.p.h., Langport East at 70 m.p.h., and at the 132nd mile post we were doing 81 m.p.h. Speed was reduced to 63 m.p.h. through Taunton, where we slipped two coaches.

At Wellington we were touching 55 and as Whiteball Tunnel was approached we dropped to 43 m.p.h. Quickly picking up speed, we passed Burlescombe at 60 m.p.h., our speed increasing to 74.5 at Tiverton and 75 at Cullompton, and for one-quarter mile we touched 81 m.p.h. Reducing speed, we passed Exeter at 1.27.30.

The next 12 miles to Dawlish were done in comfortable time, speeds ranging from 55 to 63 m.p.h. The next 8 miles to Newton Abbot were run in 9 min., and we slightly reduced speed through the station. From that point there is a stiff climb, and by the time we reached Dainton Tunnel at the top our speed had fallen to 23 m.p.h., but our engine was not all out by any means, although a shower had not improved the rails, and we had no pilot on from Newton Abbot.

Passing Totnes at good speed, we climbed to Brent, through which we ran at 26.5 m.p.h., whilst at Wrangaton we were making 33 m.p.h. At very high speed we passed through Ivybridge and ran down steadily to Plympton with brakes on, and glided through Mutley. We arrived at North-road, Plymouth, at 2.33 p.m., four minutes before time. With the load behind us there is no doubt that we could have easily completed the journey in four hours exactly. The run is tabulated below.

Our thanks are due to the officials of the Great Western Railway for the facilities given us to enable this run to be made.

Locomotive No. 4037, *Queen Phillippa*, 4–6–0; *Rolling Stock, Twelve Coaches.*

	Miles.	h. m.	Remarks.
Paddington	—	10 30	Slippery rail
Southall	9	43.5	50 m.p.h.
Slough	18.5	53.25	64 m.p.h. Maidenhead, 63 m.p.h.
Reading	36	11 7.5	Reduce speed 30 m.p.h.
Theale	41.25	14	57 m.p.h.
Thatcham	49.5	22.25	
Newbury	53	25.5	
Hungerford ..	61.5	34	
Savernake	70	45	40 m.p.h.
Westbury	95.5	12 7	Reduce speed, dead slow
Frome	101.25	15	
Bruton	111.75	26.5	41 m.p.h.
Langport East ..	130	46	69.2, 70, 75, 81 m.p.h. (132 mile post)
Taunton	143	57	Reduce speed
Wellington	150	1 4.5	55 m.p.h.
Whiteball Box ..	153.5	9	43 m.p.h.
Tiverton	158.75	14.5	60, 75, 81 m.p.h.
Exeter	173.75	27.30	Reduce speed 20 m.p.h.
Dawlish	185.75	41	
Newton Abbot ..	193.75	50	Dainton, 23 m.p.h.
Totnes	202.5	2 3	
Brent	209.5	14	26.5 m.p.h., 33 m.p.h
Cornwood	217.25	23	
Plympton	221.75	27.5	
Plymouth N. Rd.	225.75	33	

The Engagement and Loading of Involute Gearing.

By A. F. AINSLIE.

ALL who have ever worked out an example for involute gearing will agree that the calculation of the length of engagement is rather a tedious proceeding. It is believed that the diagrams of this article, which are applicable to all involute gears from a rack to the smallest pinion giving correct engagement without interference, will save gear designers much needless labour.

Notation for spur gears and for helicals in a plane perpendicular to the shaft axis :—

c is the circular pitch,
N_1 is the number of teeth in the driver,
R_1 is the pitch circle radius $= \dfrac{N_1 c}{2\pi}$,
H_1 is the addendum,
β is the angle of obliquity,
r_1 is the radius of the base circle $= R_1 \cos \beta$,
b is the pitch measured at the base circle $= c \cos \beta$,
a_1 is the intercept between the pitch point and the tip circle, measured along the common tangent to both base circles, and is the path of recess;
a_2 is the path of approach,
$a_2 + a_1$ is the path of contact,
F is the face width of the wheels.

In the case of helical gears $(a_2 + a_1)$ is the projection of the path of contact on a transverse plane. For the driven wheel use suffix 2 instead of 1. The

terms common to both driver and driven have no suffix. The inch is taken as the unit of length.

From an inspection of Fig. 1 it is readily seen that the fundamental quantities determining the length of the path of recess a_1 are the addendum H_1, the pitch circle radius R_1, and the angle of obliquity β. It is obvious also that the length of the path of contact is reduced with a decrease in the addenda or an increase in the obliquity. To find the length of the path of approach or recess it is necessary to calculate the third side of a triangle when two sides and the angle opposite to one of them are known. Then for a given ratio of addendum to pitch circle radius and with a given angle of obliquity the length of the path of approach or recess is only a question of scale, and is equal to K times the addendum, where K is the coefficient appropriate to the obliquity and to the ratio of addendum to radius,

$$a_1 = K_1 H_1 \text{ and } a_2 = K_2 H_2.$$

Values of the coefficient K have been calculated and are tabulated in the accompanying table. They

H/R.	Values of K. When β is—					
	14° 30′.	16°.	17° 30′.	20°.	22° 30′.	25°.
0.00	3.9939	3.6280	3.3255	2.9238	2.6131	2.3662
.01	3.7353	3.4324	3.1746	2.8220	2.5418	2.3147
.02	3.5348	3.2751	3.0495	2.7344	2.4787	2.2681
.03	3.3725	3.1443	2.9433	2.6575	2.4223	2.2259
.04	3.2369	3.0330	2.8513	2.5900	2.3715	2.1872
.05	3.1211	2.9365	2.7705	2.5293	2.3252	2.1515
.06	3.0206	2.8517	2.6987	2.4745	2.2829	2.1186
.07		2.7759	2.6342	2.4246	2.2440	2.0880
.08			2.5759	2.3790	2.2080	2.0594
.09			2.5228	2.3369	2.1746	2.0327
.10				2.2980	2.1435	2.0077
.11				2.2619	2.1144	1.9841
.12					2.0870	1.9618
.13					2.0613	1.9407
.14					2.0370	1.9207
.15						1.9018
.16						1.8838
.17						1.8656
Interference limiting values.						
.06269	2.9957					
.07598		2.7349				
.09042			2.5206			
.11698				2.2382		
.14644					2.0221	
.17861						1.8524

are plotted in Fig. 5 to a base of H/R and in Fig. 6 with the obliquity as base. Between these two diagrams interpolation is easy.

As an example of their use take the case of a pair of machine-cut steel wheels where the numbers of teeth are 136 and 35 of 1.5in. pitch, with an addendum of 0.4775in. and 14 deg. 30 min. angle of obliquity. For these conditions the pitch circle diameters are 64.935in. and 16.711in., from which we get the values of addendum/radius as 0.0147 and 0.0571 respectively. The appropriate values of K from Fig. 5 are 3.635 and 3.05, and the length of the path of contact is therefore

$$0.4775\ (3.635 + 3.05) = 3.19\text{in.},$$

and the number of pairs of teeth in contact is

$$\frac{3.19}{1.5 \cos 14 \text{ deg.} - 30 \text{ min.}} = 2.2.$$

If the face width of the wheel is 5.5in., then the length of the line of engagement can be taken as the width multiplied by the number of pairs of teeth in contact, and in this case comes to about 12.1in.

Helical Gears.

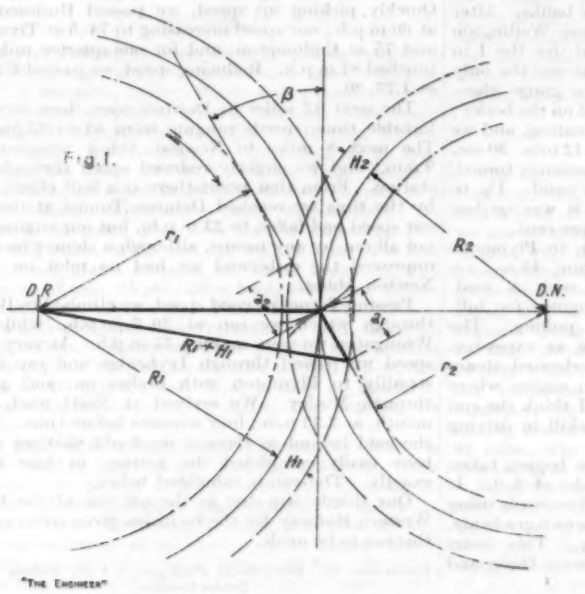
Additional notation :—

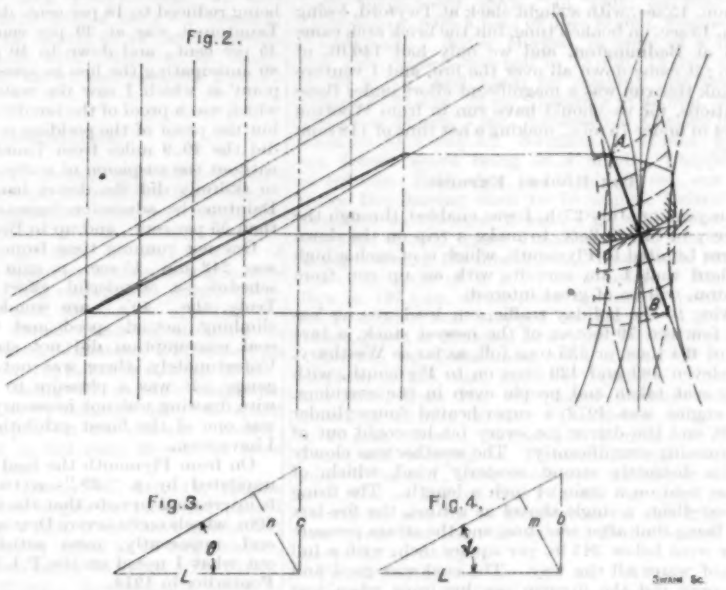
θ is the helical angle,

n is the pitch measured normal to the teeth $= c \cos \theta$,

φ is the angle of obliquity in the plane normal to the line of the teeth, and $\tan \varphi = \tan \beta \cos \theta$,

ψ is the helical angle measured at the base circle diameter,





FIGS. 1 TO 4

L is the axial pitch or lead per tooth,

m is the pitch measured at the base circle diameter and normal to the line of the teeth $= n \cos \varphi$,

c is the length of the line of engagement on one tooth,

E is the total length of the lines of engagement.

If the superficial view of the matter is taken it might appear that point contact only is obtained between helical gears, but in fact the engagement is along a straight line on each tooth. To examine this in terms which are quite general we can consider the sides—that is, the flanks and faces—of the helical teeth as made up of a regular repetition of involutes to the same base circle in successive transverse planes as in Fig. 2. There it is easily seen that the common tangent A B to the two base circles, or the projection of the path of contact on a plane perpendicular to the shaft axis, is the common normal to the teeth at the points where they are in contact with each other. Therefore the plane which passes through A B—of which A B is the trace—and which is parallel to the shaft axis, cuts all the recurring involutes at right angles. It is clear also that the distance in the direction parallel to the shaft axis between any two successive transverse planes is directly proportional to the distance between those involutes when measured along the projection of the path of contact or along the circumference of the base circle. It follows, therefore, that the successive points of contact or engagement lie on a *straight line* in the plane, of which A B is the trace, tangent to the base circles; and the plane, which is perpendicular to the plane A B through the line of engagement is tangent to the tooth surface and is a side of the tooth of the generating rack. The line of engagement is parallel to the helical angle formed at the base circle diameter by the ends of the involutes on the successive transverse planes, and the tangent of this angle is b/L.

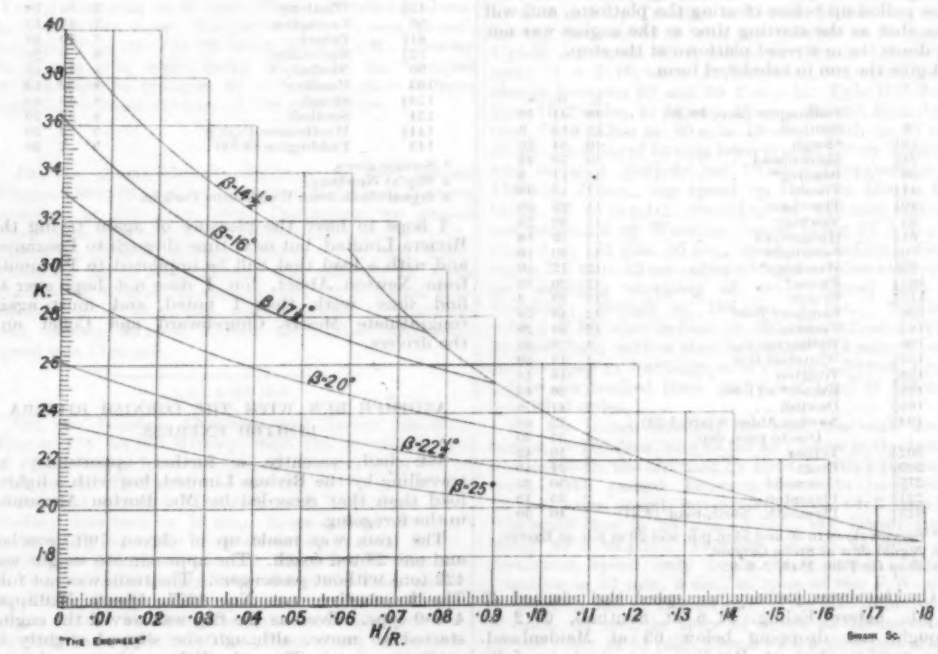


FIG. 5

The right-angled triangles, Figs. 3 and 4, show the fundamental relationships between the various terms at the pitch circle diameter and at the base circle diameter respectively.

$$\sin \theta = n/L, \sin \psi = m/L, \&c.$$

Then, remembering that $b = c \cos \beta$ and $m = n \cos \varphi$, we get

$$\sin \psi = \frac{n \cos \varphi}{L} = \sin \theta \cos \varphi,$$

$$\cos \psi = \frac{n \cos \varphi}{c \cos \beta} = \frac{\cos \theta \cos \varphi}{\cos \beta},$$

$$\tan \psi = \frac{c \cos \beta}{L} = \tan \theta \cos \beta.$$

The true length of the line of engagement on one tooth is

$$c = \frac{(a_2 + a_1)}{\sin \psi},$$

$$= \frac{(a_2 + a_1)}{\sin \theta \cos \varphi},$$

$$= \frac{L\,(a_2 + a_1)}{n \cos \varphi};$$

and the total length of the lines of engagement is

equal to the length of engagement on one tooth multiplied by the number of times the axial pitch is contained in the face width of the wheels, or

$$E = \frac{e\,F}{L} = \frac{F\,(a_2 + a_1)}{\pi \cos \varphi}.$$

As an example take the case of a pair of marine gears of 58.25in. effective width having 71 and 463 teeth cut with a hob of pitch π normal to the thread of 0.583001in. and with a generating angle φ of 14 deg. 29 min. 31.5 sec. These hob dimensions result from $^7/_{12}$in. lead on 5.5in. pitch circle with 29 deg. included angle between the sides of the thread, measured on the plane through the axis of the hob. Take $^6/_7$in. as the lead per tooth or axial pitch. Then the helical angle, being the angle whose sine is π/L, is 30 deg. 40 min. 20 sec., and the circular pitch is $(L \tan \theta)$ 0.67783in. The pitch circle diameters are $(N\,c/\pi)$ 15.319in. and 99.897in. and each has an addendum of 0.1855in. The angle of obliquity is obtained from $\tan \beta = \tan \varphi \sec \theta$ and is 16 deg. 43.6 min. The values for the ratio addendum/radius are 0.0242 and 0.00371, and from Figs. 5 and 6 we obtain the appropriate values of K as 3.110 and 3.406. The length of the path of contact projected on a transverse plane is thus 0.1855 (3.11 + 3.406), which equals 1.209in., and then the total length of engagement becomes

$$\frac{58.25 \times 1.209}{0.5830 \times 0.9682} = 124.8\text{in.}$$

Loading Intensity.

Notation:—

P is the horse-power transmitted,
$r\,p\,m_1$ is the number of revolutions per minute,
W is the intensity of line loading in pounds per inch run of engagement.

The load tangent to the pitch circles is

$$\frac{P \times 33000 \times 12}{R_1 \times r\,p\,m_1 \times 2 \times \pi}.$$

Swing this round to be tangential to the base circles and it becomes

$$\frac{63025\ P}{R_1\,r\,p\,m_1 \cos \beta},$$

and then the load normal to the line of engagement equals

$$\frac{63025\ P}{R_1\,r\,p\,m_1 \cos \beta \cos \psi}.$$

The intensity of loading is therefore the normal load divided by the total length of engagement and is

$$W = \frac{63025\ P}{R_1\,r\,p\,m_1 \cos \beta \cos \psi} \times \frac{n \cos \varphi}{F\,(a_2 + a_1)},$$

$$= \frac{63025\ P\,c}{R_1\,r\,p\,m_1\,F\,(a_2 + a_1)}.$$

In the example chosen above for the engagement of the helical gears the horse-power transmitted is 10,000 at 1800 revolutions per minute, and therefore

$$W = \frac{63025 \times 10{,}000 \times 0.67783}{7.6595 \times 1800 \times 58.25 \times 1.209}$$

= 440 lb. per inch run of engagement.

If the addendum had been taken as 0.1565in., the other dimensions remaining unaltered, the length of engagement would be 106in. and the normal loading 518 lb. per inch run of engagement.

The usual method of specifying the loading intensity is in pounds per inch width of wheel face, and in the case considered is

$$\frac{63025 \times 10{,}000}{7.6595 \times 1800 \times 58.25}$$

= 785 lb. per inch of width.

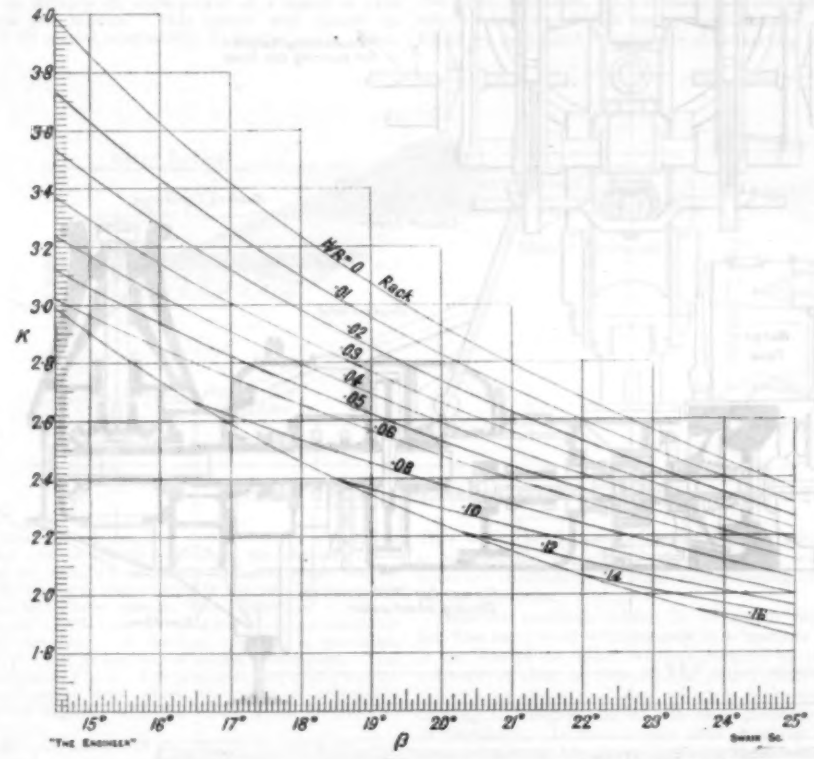


FIG. 6

The true loading intensity is 440, against the nominal value of 785—a difference of nearly 80 per cent.

Engineer-Commander H. B. Tostevin, D.S.O., in replying to the discussion on his classical paper on "Reduction Gears," read at the spring meeting of the Institution of Naval Architects in 1920, said:—"... it must be emphasised that the load per inch width of pinion face does not in itself convey a true idea of the intensities of pressure and stress on the teeth as they are affected by the helical angle, the tooth proportions and the normal angle of obliquity. It is therefore essential in any particular case to analyse the contact between the teeth and obtain the total length of contact and normal load." To calculate the true value only requires the additional knowledge of the circular pitch and the projected length of engagement. Figs. 5 and 6 give the values of the length of the path of contact almost by mere inspection, and the ease with which it can be determined should induce designers to use the true value of the loading instead of the nominal figure, which is seen to be so very much in error.

It is worth noting that when the centre distance is different from the designed dimension, both the obliquity and the addenda are modified. The angle of obliquity is the angle between the common tangent to the base circles and the perpendicular, through the pitch point, to the line of centres. The base circles have been fixed by the cutting conditions, and the pitch point divides the line of centres in the ratio of the numbers of teeth in the two wheels in gear—that is, in the ratio N_1/N_2—and the addendum is the length from the pitch point to the tip circle of the teeth. If both wheels are designed with the same addendum and the centre distance is changed, the addenda are necessarily altered, being reduced by dissimilar amounts if the centre distance has been increased, and increased if the centres have been brought nearer together.

Occasionally, for exceptional purposes, unusual proportions of addendum to pitch are used, but the great majority of gears are made to the Brown and Sharpe standard, viz., that the addendum is equal to the normal pitch divided by π. For any such definite proportions the smaller the pitch the smaller the addendum, and from Fig. 5 it can be seen that, for a given pitch circle diameter, the smaller the addendum is made the greater becomes the number of teeth in gear, as it varies with K directly. The smoothest running is obtained with the smallest teeth which can carry the load safely without danger of fracture, distortion, or abrasion, because, not only does this give the maximum number of teeth over which the load is distributed simultaneously, but the accompanying reduction in the addendum arising from the reduced pitch also reduces the maximum slipping velocity.

The Vermot Shunting Tractor.

THE petrol shunting locomotive is now extensively used in France for railway stations and marshalling yards and also industrial work. Experience would seem to show that it is superior to steam and horse haulage, on account of its extreme flexibility, the low cost of fuel and the reduced charges for attendance and upkeep, especially during the time it is standing by.

A novel design of petrol shunting tractor, which embodies several ingenious mechanical devices, is the Vermot Locomoteur, constructed by the Usines de Constructions Mécaniques de Villefranche-sur-Saône, which forms the subject of the present article. It is well known that the tractive effort of any locomotive is directly dependent on the power it develops and its adhesive weight. If the power is too large for the weight, then the wheels will slip and a waste of power takes place. Thus, the weight of a locomotive has a definite limiting effect on the power which may be usefully developed. The object of designing the Vermot tractor was to make a comparatively light self-propelled rail vehicle which would haul about 150 tons on the level. It was also desirable that such a machine should be moderate in first cost, easy of manipulation and small in size. The tractor itself is not heavy, having a total weight of only 4 tons, but advantage is taken of a mechanical device whereby part of the weight of the carriage or wagon to be hauled is transferred to the centre of gravity of the tractor, thereby increasing the distributed weight on the four wheels to about 10 tons. If a coefficient of friction of one-sixth be assumed, the

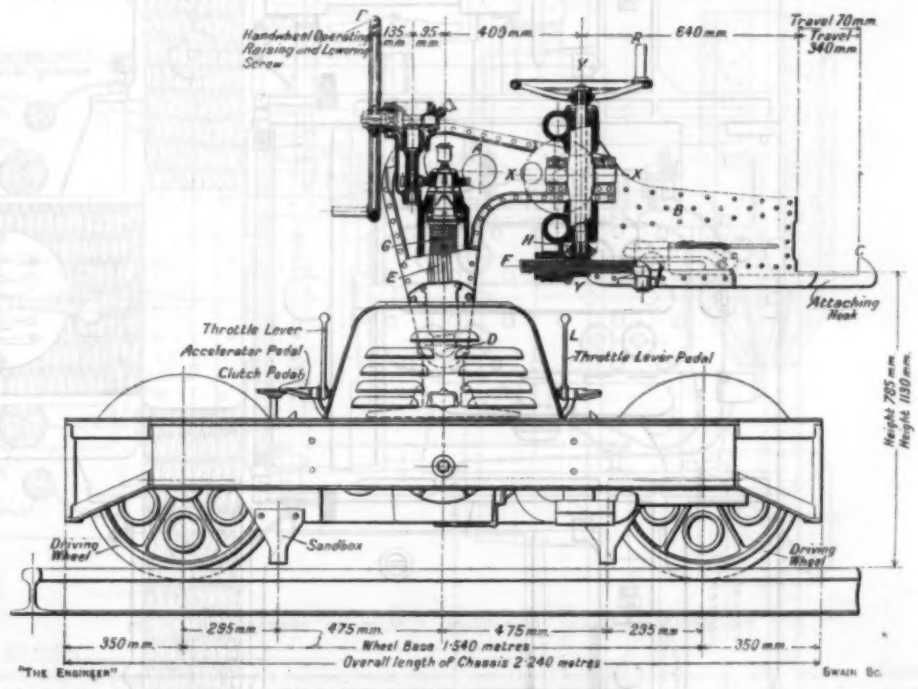


FIG. 1—THE VERMOT SHUNTING TRACTOR

THE VERMOT SHUNTING TRACTOR

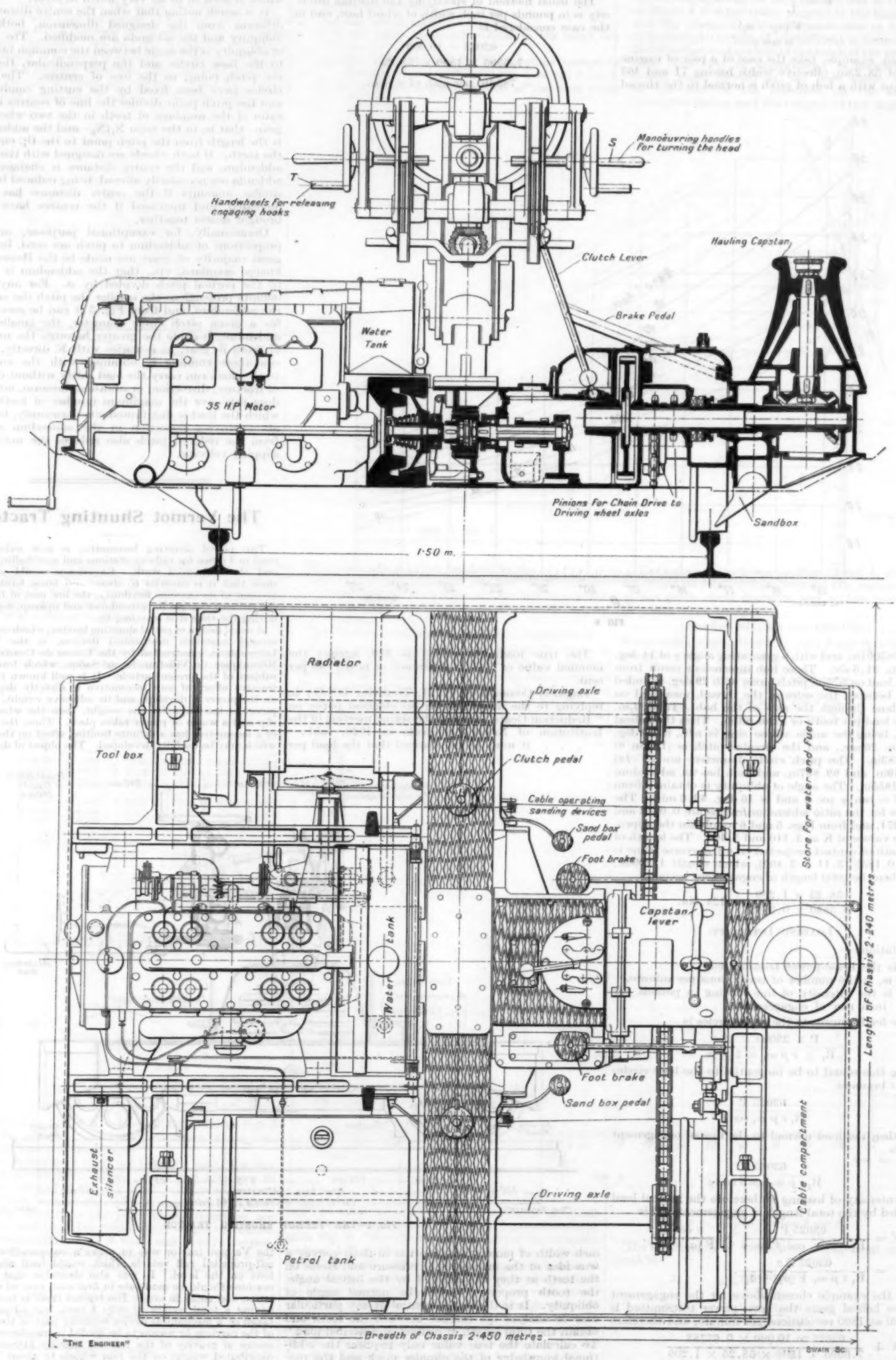


FIG. 2

total tractive effort is 1666 kilos., which by using the sanding devices may be raised to about 2000 kilos. As the motor is rated on a basis of 1450 kilos. effort, the design allows its full power to be usefully employed. From theoretical considerations, the tractor should be capable of dealing with loads up to 240 tons, and the makers are prepared to guarantee, in practice, a figure of from 150 to 180 tons.

The general appearance of the tractor and its mode of application is illustrated in the Figs. 3 to 6 on page 694, while the drawings reproduced in Figs. 1 and 2 serve to show details of construction and arrangement.

The motive power is supplied by a Rochet-Schneider four-cylinder 100 mm. by 120 mm. engine, which is designed to develop 35 horse-power at a speed of 1400 revolutions per minute. This motor was chosen on account of its special adaptability to tractor work. From Fig. 3 it will be seen that the motor with its clutch and three-speed gear is neatly housed in the chassis of the tractor, along with the necessary fuel and water supply tanks. The power is transmitted to the two driving axles by chains, and three speeds, the highest of which is 18 kilom., or a little over 11 miles per hour, are available for either direction. A hauling capstan is provided, which may be put in and out of action as required. This is shown in use in Fig. 6. The principal part of the tractor is the overhanging arm, which by means of adjustable sliding hooks engages with the buffer beam or transom of the carriage.

An important feature of the design to which we have already referred is the device whereby part of the weight of the carriage to be hauled is transferred to the centre of gravity of the tractor at a fixed central support secured to the centre transverse member of the chassis. To do this, the front part B—Fig. 1—of the overhanging arm is made practically one with the buffer beam of the carriage, by being gripped to it with the hooks C. The motion of the hooks is controlled by the hand wheel R through bevel pinions H and the leading screw F. The foremost part of the arm B is attached to the movable support A in such a manner that it is free to move through 18 deg. to 20 deg. about the axis X X, and also to turn on the axis Y Y, these movements being controlled by the handles S—see Fig. 2. Two further hand wheels T enable the lateral distance between the hooks to be varied as desired. The back part of the overhanging arm is of plate construction, and surrounds a rigid centre support attached to the centre transverse member of the tractor chassis. It is attached to this support by swivel links D, the actual fastening being made through heavy laminated springs E, which take up the shock on coupling. This arrangement permits of part of the weight of the carriage being transmitted through the overhanging arm to the centre of gravity of the tractor, but an elastic element is introduced by the springs. The whole arm is capable of being turned through 360 deg., so that attachment may be made either at the front or the back of the tractor, which is arranged so that it can either push or pull.

Some particulars may be given of the time taken to couple and uncouple the tractor to the carriage. Assuming the tractor to be at rest in a position 6ft. from the carriage to be shunted, the attachment, according to tests which have been carried out, can be made in 25 sec. after the order for starting the operation has been given. Similarly, the tractor can be uncoupled from the carriage in 10 sec. to 12 sec., which time is counted from the time the order is given until the tractor has resumed its former position 6ft. from the carriage. The detachment may also be made with the tractor and carriage in motion, advantage being taken of the run of the vehicles for shunting purposes.

On the platform of the tractor chassis is a capstan which may be worked at three speeds. With the brakes locked, this capstan is capable of developing a tractive effort of 4300 kilos. at a speed of 0.6 m. per second. This power is large enough to enable it to deal with any reasonable load required in ordinary shunting work. Illustration Fig. 6 on page 694 shows the capstan in use, and the comparative long length of cable used may be noted.

The following are particulars of the working of a Vermot shunting tractor at the railway station of Villefranche-sur-Saône, the tests being made in the June of this year. For a period of eight days the tractor was constantly in use for fifteen hours per day, its work consisting of shunting four to five and sometimes ten to twelve wagons, both loaded and empty, with weights of from 150 to 200 tons. According to official figures, the actual consumption of petrol was as follows:—In eight days of fifteen hours, or 1200 working hours, the total amount of fuel consumed was 335 litres, or nearly 73.5 gallons. This works out at 2.79 litres per hour, or a little over 0.6 gallon of petrol per hour. With regard to lubricating oil, 13.65 kilos., or about 3.3 gallons, for the whole period of eight days, which appears to be very satisfactory. Considerable interest has been taken in this new tractor by the engineers of both British and Indian Railway and the British representatives are Clifford White and Company, Limited, 27, Pavilion Road, Knightsbridge, London.

Current Retards on American Rivers.

SEVERAL of the large silt-bearing or muddy rivers in the western parts of the United States have a disagreeable propensity for shifting their channels erratically and cutting away their banks, from time to time, with disastrous effects to land and property. One remedial method is to protect a threatened point, or to stop further caving of a bank which has been attacked, by covering it with some of the various types of brush and stone mattress, or sometimes by a blanket of concrete slabs strung on cables. This work, while used extensively and successfully, is necessarily somewhat slow, and in some cases becomes ineffective through undermining of the toe of the mattress.

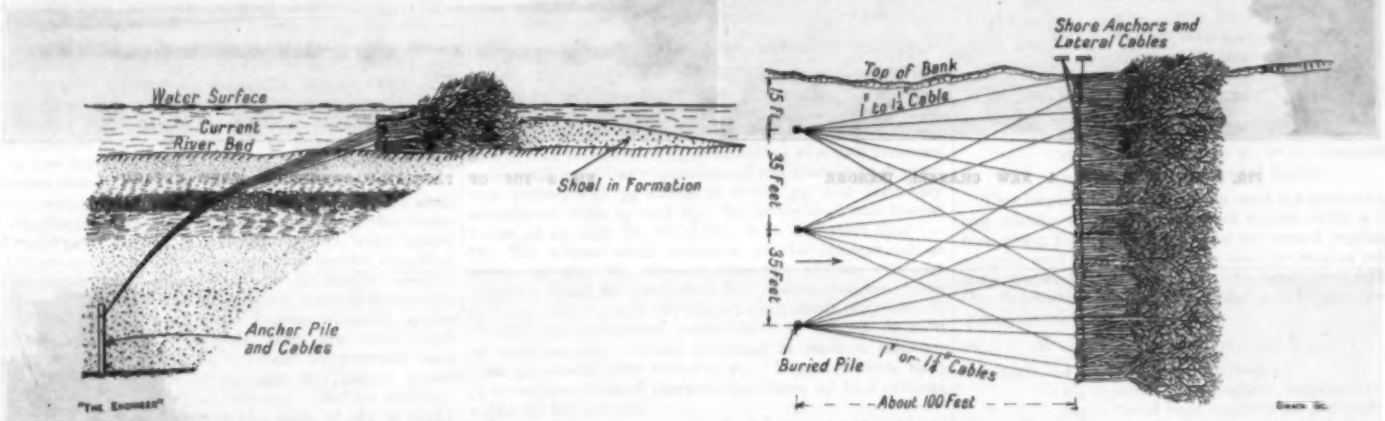
Another method, which is of much later date, but has been used with success in a number of cases, is the use of so-called current retards to check the velocity of flow at the danger point, thus reducing the erosive effect, and also, which is more important, causing the deposition of silt as a protective beach or foreshore. In some cases this shoaling at flood-time is built up far above ordinary high-water stages, so that the made land becomes available for cultivation. Fig. 4, page 690, shows a caving bank where the river has been cutting a new channel inshore. Further down is shown one of the retards, which has checked the rapid and eroding current and is causing the shoaling up of the new channel. The normal channel of the river is at the right of the sand bars.

These current retards are, in effect, permeable spur dykes, extending from the bank and practically at right angles with the current. A limited use has been made of steel spiders placed 6ft. to 10ft. apart, and connected by wire strands, which soon catch enough driftwood and brush to check the current and cause silting. A much more substantial and more extensively used method is to build the retard of a thick layer of trees, having their trunks attached to cables which are anchored to concrete piles buried in the river bed. These tree retards have been used with great success on a large scale along the swift, erratic and silt-laden Missouri River, and also along other lesser streams of the same character. They are built mainly by the Woods Brothers Construction Company, of Lincoln, Nebraska, which company owns the patents on the Bignell water-jet pile, which is used for the anchorages. The general construction of a retard is shown in Figs. 1 and 2.

An alternative design which has been used in some cases where trees are not readily available, consists of a skeleton raft of railway sleepers strung on steel cables. The rows of sleepers are staggered so that their ends overlap, each cable passing through two sets of sleepers, and spacing blocks are also inserted to increase the distance between the sleepers. The upstream ends of the cables are led to anchor cables attached to buried piles. An apron of willow brush, hanging beneath the downstream of the raft, soon causes silting to commence. This silting proceeds with increasing rapidity until the raft is sometimes buried immovably in the shoal or sand bar.

The reinforced concrete water-jet piles, which are an essential feature of this system, are the invention of Mr. Edward Bignell, formerly an engineer on the Chicago, Burlington and Quincy Railway, and now consulting engineer for the Woods Company. They are of rectangular section, fitted with pipes for water jets from a hose which is attached by a patented detachable coupling. With these jets the pile can be sunk in any loose material without driving. The pile construction is shown in Fig. 3. Anchor piles for this protective work are 20ft. long, and 14in. square, with chamfered corners and point. Those for foundation work, which are 40ft. to 50ft. long and 16in. square, weigh about 2½ tons. Steel reinforcement consists of eight longitudinal bars, outside of which is a rectangular wrapping of wire netting.

Through the centre of the pile extends a 4in.



FIGS. 1 AND 2—DIAGRAMMATIC SKETCHES SHOWING METHOD OF CONSTRUCTING THE RETARDS

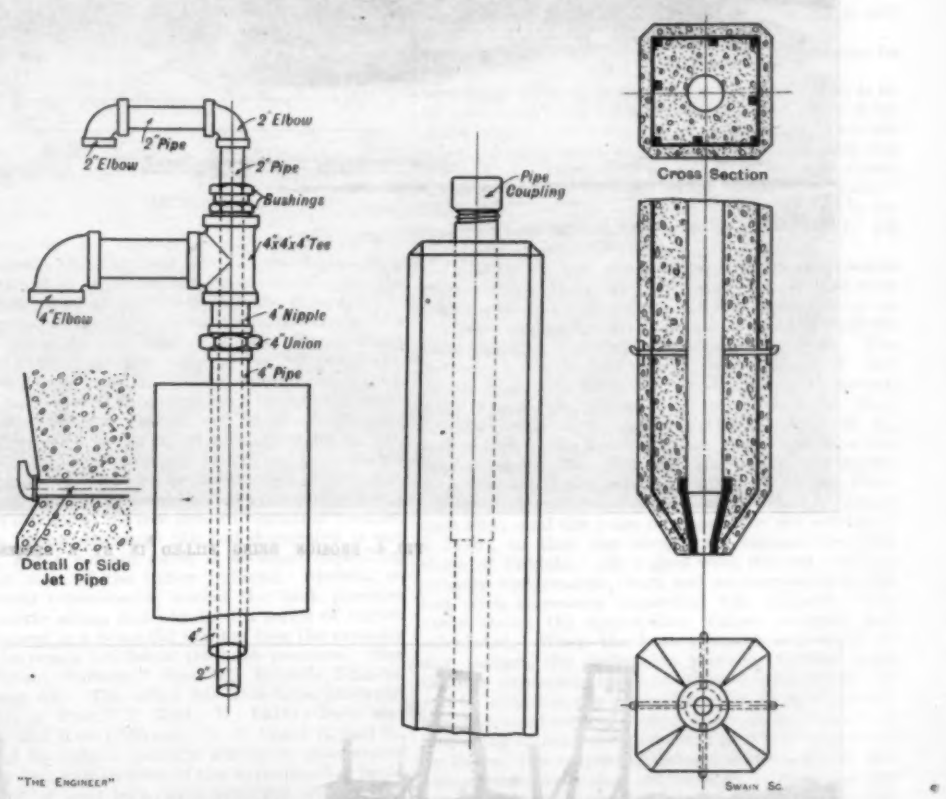


FIG. 3—ARRANGEMENT OF BIGNELL REINFORCED CONCRETE WATER-JET PILE

PROTECTING RIVER BANKS BY CURRENT RETARDS

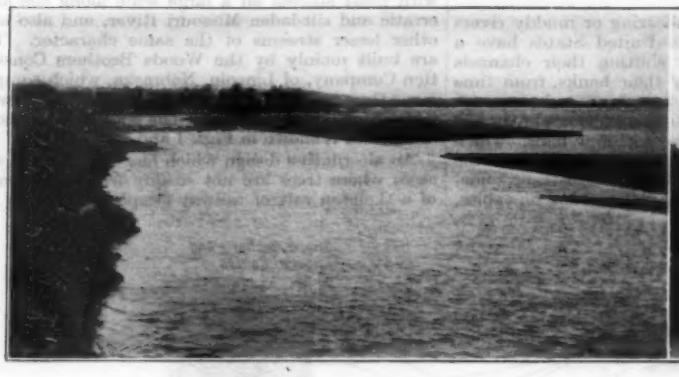


FIG. 4—RIVER CUTTING A NEW CHANNEL INSHORE

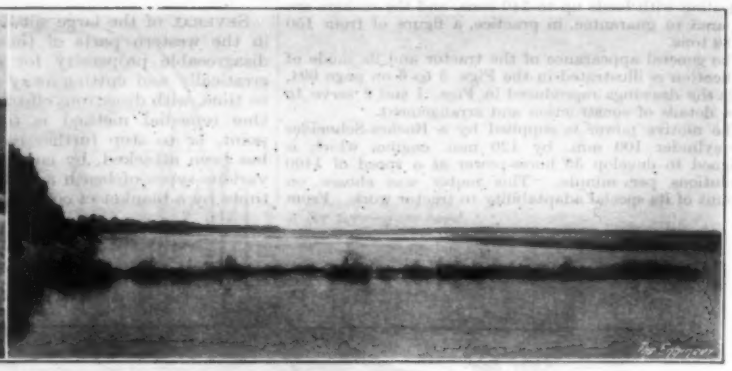


FIG. 5—TOP OF PARTIALLY-SUBMERGED TREE-RETARD

FIG. 6—EROSION BEING FILLED IN BY A SERIES OF RETARDS

FIG. 7—STEAMERS AND BARGES FOR RIVER PROTECTION

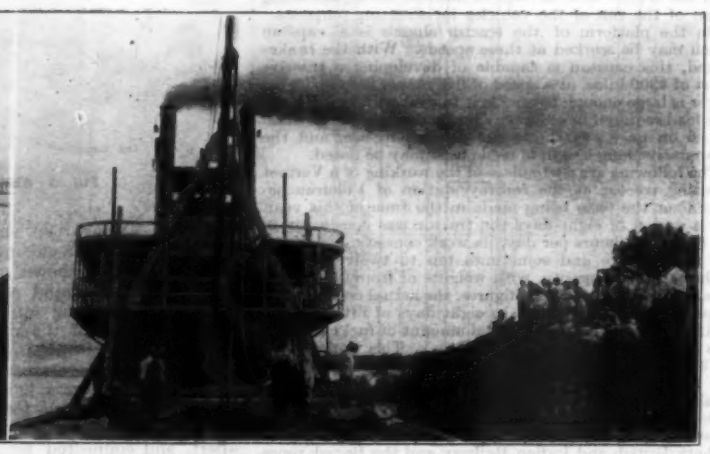


FIG. 8—BOW OF STEAMER WITH PILE READY FOR SINKING

iron pipe, the lower end of which is screwed into a cast iron tapering nozzle embedded in the point of the pile and forming a 1¼in. or 2in. jet to bore through mud, sand, clay or gravel. The pipe projects far enough above the head of the pile for the attachment of the hose coupling. At intervals of 4ft. along the pipe are four ¾in. branch or lateral pipes extending to the four faces of the pile, each branch ending in upturned elbow or nozzle which lies in a recess in the concrete. The vertical jets from these nozzles loosen and break up the material, so as to eliminate binding or skin friction, the pile thus dropping easily to the desired depth by its own weight. As soon as the jets are stopped the sand settles and compacts, gripping the pile until it becomes immovable. In the 50ft. foundation piles the first set of side jets is 14ft. below the head, and the succeeding sets are spaced respectively 12ft., 10ft., 8ft. and 4ft. apart, the lowest being 2ft. above the point.

In some cases a 2in. pipe is placed within the larger one and screwed into the nozzle, so that the larger pipe has no bottom outlet and serves only the lateral jets. At the head of the pile the smaller pipe extends above the other, the latter being closed by a tee for the hose coupling. This arrangement is shown also in Fig. 3.

Jet pressures of 100 lb. to 300 lb. per square inch are employed, according to the character of the material to be penetrated. A long pipe or rod, with forked end fitted over the hose coupling, enables this coupling to be unscrewed when the pile is finally seated. In foundation work the piles may extend above the bed of the river. But for the current retards, where the piles are simply anchors, they are sunk until their heads are 40ft. to 60ft. below the normal river bed in order to provide against the heavy scour which may occur at flood seasons. Before sinking, each pile has attached to it the ends of six or eight 1in. cables, 200ft. long, the attachment consisting of a steel sleeve fitted about 4ft. below the head of the pile.

Stern-wheel steamboats are used in sinking the piles, the steamer having at the bow a tall derrick or gallows frame, this being inclined so that its head projects far enough to suspend a pile in front of the bow. A block and tackle on the head timber of the derrick frame provides for handling and lowering the pile. Fig. 7—page 690—shows two of these steamers, with barges in front for carrying the piles and trees, while Fig. 8 is a view looking forward of the bow, with a barge in front; a pile is suspended ready for sinking, and has the jet hose attached. Fig. 5 shows the top of one of the submerged tree retards.

In building a retard, the first pile is driven about 15ft. to 20ft. from the bank, in water 10ft. to 20ft. deep. The others are spaced 35ft. apart. Trees 40ft. to 90ft. high, with trunks from 8in. to 24in. diameter, are cut down, hauled to the shore, by petrol tractors and towed to the site on barges. On the deck of the barge the trees are connected in groups of fifteen to thirty, each group having a ¾in. cable which is secured to each trunk by a half-hitch and by heavy 6in. staples. Another cable is led to a buried anchor or "deadman" on shore. The anchor cables from the anchor piles in the river bed are firmly secured to the groups of trees, and then the steamer pulls the barge away so as to launch the trees into the river.

Owing to the line of pull and the swift current the first groups are carried to the bottom. Others are added until the dense mass is built up to the surface of the water and for the required length. The anchor cables are interlaced as shown in the plan, Fig. 2, so as to distribute the stresses and to hold the retard in its proper position. From 600 to 700 trees may be required for a retard 200ft. long in deep water. They will gradually be buried in the sand and silt, so that they will remain indefinitely to bind the shoal and protect it against future attacks of the river.

These retards are from 100ft. to 400ft. long, and they are spaced 500ft. to 1500ft. apart, their number, spacing and length at any point being adapted to the curvature of the river, the direction and force of the eroding current and other local conditions. The first one is built well above the point at which cutting or erosion is taking place, its position being selected with a view to diverting the current or new channel as well as checking the flow and causing sedimentation. They are always built in series, since a single retard would be of little effect.

Silting or shoaling above the retard proceeds slowly, since the tree mass is permeable. But the checking of current velocity in and below the retard by the interwoven mass of tree trunks, boughs, twigs and leaves causes rapid silting. In some cases a shoal 10ft. deep has been formed for a distance of 700ft. to 800ft. below the retard in a week or two. Fig. 6, page 690, shows a broad stretch of shoal where the bend was deeply eroded by the current, but has been filled again as the result of a series of retards extending out from the new bank. One of these is shown partly protruding from the sand beyond the tree which lies awash in a shallow pool. The main and normal channel of the river is at the left, and this shoal will eventually dry out and become firm land.

Protective works on a small scale or at scattered points not selected for their strategic positions, would be of little practical effect. Thus work done by individual landowners here and there would be both costly and ineffective. To meet this condition, some States having rivers of the troublesome character described have established laws permitting groups of landowners to organise protection districts, similar to drainage and irrigation districts. Such a district has power to issue bonds and to contract for the construction of river-bank protection works either continuously or at all points needed within the district.

The Depression Effect in Nozzle Flow.

By HENRY A. HEPBURN, B.Sc. (Lond.), A.M.I. Mech. E.

(1) THEORETICAL AND EXPERIMENTAL EVIDENCE.

IN a former paper* the action of an ejector was shown to be dependent upon the tendency of steam or gas to continue expansion below the normal back pressure in the ejector system. That is to say, steam at a source pressure of p_0, exhausting at a sink pressure p_1 is capable, on free expansion, of maintaining a depression pressure of p_2 which is below p_1, but definitely associated with p_1 and p_0. In order that the lowest value of p_2 may be obtained, it is essential that:—(1) The nozzle shall conform to the theoretical as given by the St. Venant theory; (2) an efficient channel shall be provided for re-compression from p_2 to p_1 again; and (3) the system shall only admit, if any, an additional mass which is strictly defined in amount, any excess reacting in such a manner that p_2 would rise towards p_1. It was shown that p_2 is independent of the induced mass up to a critical value of the latter.

It is of interest to examine how far the theory developed is applicable to steam flow in nozzles, whether of the simple convergent type or compound.

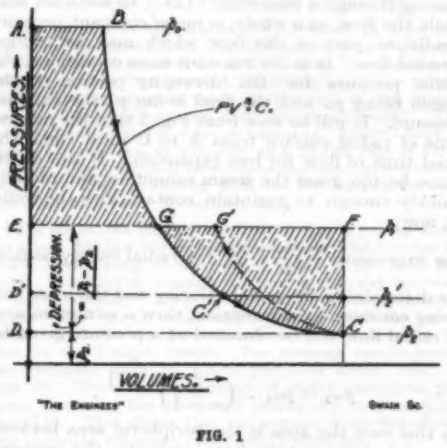


FIG. 1

Steam has a decided tendency to over-expand on exit from a nozzle, and this effect leads to avoidable losses. In practice it is usual to fashion the nozzles for use in turbines so as to under-expand the steam, or, in other words, to release it from the nozzle before the exhaust pressure has been reached. The amount of under-expansion may vary up to 20 per cent., according to the heat drop and terminal conditions. Various curves used in design may be referred to in books on "Turbine Design." The over-expansion effect appears to be an effort at depression on the part of the high velocity steam. Given the suitable environment of an ejector intake cone, the full depression pressure p_2 would be set up round the exit area, but in view of the free inflow of external medium into the jet on discharge the full depression is not reached, but a certain value is attained depending upon the mass of the inflow induced. Stodola, in his classical experiments, varied the back pressure of the nozzle steam and obtained a series of curves which showed in a beautiful manner how the pressure within the nozzle fell below the back pressure. (See "The Steam Turbine," Stodola; English Edition, 1905, page 64.) The effect has also been observed by Morley ("Proc." I. Mech. E., 1916); Jude and Mellanby and Kerr ("Trans." N.-E. Coast E. and S., 1921) and by others, but the author is unaware of any published explanation of the experimental facts. The action is used in a wide practical way in the steam and air ejector; the Venturi meter and the Ferranti valve. The writer will produce Stodola's experimental curves from purely theoretical considerations.

(2) THE DEPRESSION RELATIONSHIP.

This, in words, may be summarised as:—"The back pressure in a free expansion system is the mean effective pressure between the initial pressure and the depression pressure." The term "system" is used because the relationship holds good in the case of an ejector for an induced mass up to a critical value, as well as in a nozzle into which no additional medium is allowed to flow. The kinetic energy of steam issuing from a nozzle must be immediately used for performing external work, on turbine blades or in other ways, or it will be used in setting up a state of stress at the exit area. It can do this by lowering the back pressure from p_1 to p_2, and by inducing external medium to flow into the jet, which is accelerated and moved along with the jet to which it adds its own kinetic energy. Once the state of stress, or depression, is established, there is no further demand upon the jet for work, but the initial and back pressures may not be varied, without a corresponding alteration in the depression pressure p_2.

For a gas—

$$p_0 = a\,p_2 \left[\frac{K\{x(n-1)+1\}}{K.n-(x-1)(n-1)(1-K)}\right]^{\frac{n}{n-1}} \quad (1)$$

in which p_0 = the initial pressure.
p_2 = the depression pressure.
p_1 = the back pressure.
$x = \frac{p_1}{p_2}$.
K = the nozzle energy co-efficient.
n = the index in $p.v^n$ = constant.
a = an experimental factor.

This expression may also be used for steam expanding wholly in the superheated region with $n = 1.3$, but when flow passes into the saturated regions it is simpler and more accurate to use the similar relationship derived from equating the heat drop (down to the depression pressure) to the total back pressure (or depression) work.

or $$K\,.\,J\,.\,(H_0-H_2) = (p_1-p_2)\,V'_2 \quad . \quad . \quad (2)$$

in which J = Joule's equivalent.
H_0 = total heat content at pressure p_0.
H_2 = total heat content at pressure p_2.
p_1 = the back pressure.
p_2 = the depression pressure.
V'_2 = the actual final voume at $p_2 = x_2 V_2$.
x_2 = the dryness fraction.
V_2 = spec. volume.

or $$K\,.\,J\,.\,(H_0-H_2) = (p_1-p_2)\,x_2\,V_2. \quad . \quad (3)$$

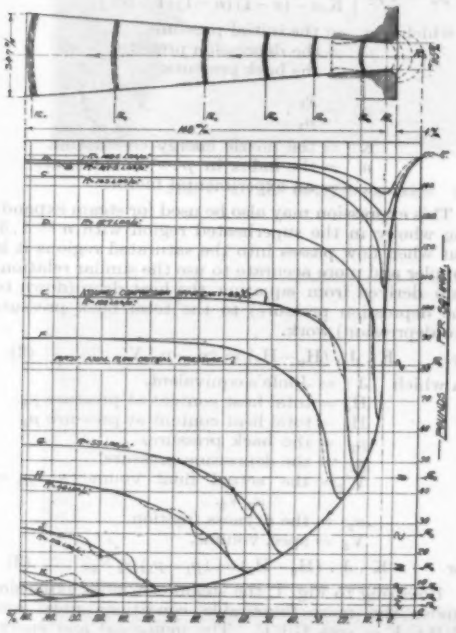
Referring to Fig. 1, the steam continues expansion under the most favourable conditions until area A B G E = area G F C. The momental and energy conditions of flow are then satisfied, and unless p_0 be raised, p_2 will reach no lower value. An induced mass equal to a maximum or critical amount $\frac{A\,B\,G\,E}{E\,G\,C\,D} = m_1$ may flow into the nozzle system without disturbing p_2, but if m_1 be exceeded C will move up to C^1 until $\frac{A\,B\,G\,E}{E\,G\,C^1\,D^1} = m$. This mass may be very large when p_2 is near p_1, or *vice versâ*, if p_2 is to be prevented from falling to a low value, m must be made large. This is the aim of good design, to obtain a free inflow of steam at the exhaust pressure into the exhaust jet. Depression entails large losses in steam turbine nozzles unless counteracted by under-expansion, as will be seen below. There should be no artificial restraint on inflow to a high velocity jet if depression is to be avoided.

In order to test the accuracy of the depression relationships (1), (2), and (3), it was thought that they might give an explanation of the excess drop in nozzles tested under the Stodola conditions of variable back pressure, but with a fixed initial pressure. The curves A to L in Fig. 2 were obtained and agree closely in form to the experimental curves. The expressions (2) and (3) were used, as they fix the value of p_2 and also the velocity at p_2, and therefore the exact position in the nozzle of the depression; p_0 has been taken at 150 lb. per square inch with an initial superheat of about 25 deg. Fah.; p_2, the final exhaust pressure, as 3.0 lb. per square inch abs.; and the mass of steam flow per second as 0.33 lb., so that the results are comparable with those of Stodola. All values were derived from an entropy temperature chart and an increasing nozzle loss with increasing expansion was adopted. The table shows the appropriate values assumed and calculated. When the back pressure is lowered at any instant, the depression pressure travels down the free expansion curve to its new fixed value. It will be seen that the expansion down to p_2 is normal, but the compression taking place in a channel of increasing instead of diminishing area is accompanied by losses. The surprising deduction is made that the compression losses may not be large, reckoned on the compression work required from p_2 back to p_1, but the reaction upon the expansion area above p_1 is serious. The higher curves are very symmetrical about the line through the minimum area, probably because the divergence near that area is a fair reversed image of the convergence. The lower curves have expansion and compression in the divergence, and consequently have greater losses associated with the flow.

In drawing the curves the procedure has been to obtain the critical and final areas and then to fix upon a divergence rate to agree with the Stodola nozzle as closely as possible. The back pressures were then selected for each curve A to L and p_2 obtained from (2) or (3). The velocity at each p_2

* THE ENGINEER, October 20th and 27th, 1922.

was calculated and p_2 plotted against the distance from the nozzle entry. The value of the loss coefficient on compression being unknown, it was decided to take curve E and assume a loss that would give a fair copy of the experimental compression line. The compression loss for that curve is 31 per cent., or the compression efficiency is 69 per cent., reckoned on the area E G C D of Fig. 1. This is a very fair efficiency in view of the sudden enlargement, but represents the least value if $p_2 = 104$ lb. per square inch is to be maintained. A reference to Fig. 1 will show that p_2 can be stationary so long as the loss G G^1 C does not exceed the area G F C = area A B G E = available work of depression. It is evident that the loss must be made up by abstraction of



R=130 Lbs/in² R=3·0 Lbs/in² STEAM FLOW PER SEC. = 0·33 POUND

CURVE	A	B	C	D	E	F	G	H	J	K	L
P_1	188·5	167·5	150·0	137·0	124·0	90·0	55·0	44·0	33·0	22·0	13·5
P_2	130·0	114·0	111·0	44·0	44·0	38·0	32·0	44·0	8·0	3·7	0·09
$\frac{P_2}{P_1}$	0·51	0·68	0·77	0·41	0·5	0·8	0·8	0·59	0·40	0·23	0·4
$\frac{P_2-P_3}{P_1-P_3}$	0·66	0·7	0·78	0·70	0·56	0·53	0·52	0·50	0·50	Curve not calculated	
K_1	0·96	0·97	0·96	0·95	0·94	0·93	0·93	0·91	0·90	0·89	0·89
$\frac{P_2-P_3}{P_1-P_3}$	0·50	0·5	0·63	0·40	0·40	0·50	0·0	0·48	0·50	0·0	0·0

* Actual figures in middle (C) and (E) respectively.

"THE ENGINEER" SWAN SC.

FIG. 2

energy from the area A B G E and 31 per cent. of area E G C D may be much more than that percentage of area A B G E. In the case chosen, curve E, the losses amount to 92 per cent. of the available energy above the back pressure line, although only 31 per cent. of area E G C D.

If X = gross available work above p_1,
K = loss coefficient on expansion p_0 to p_1,
a = loss coefficient on expansion p_1 to p_2,
W = compression work (net),
b = compression efficiency,

then the net available work of the steam jet.

$$= K X - W \left(\frac{1 - a\,b}{b}\right) \quad . \quad . \quad (4)$$

(3) Effect of Depression on Excess Discharge.

Jude has indicated very clearly (see "Trans.," N.E. Coast E. and S., Vol. xxxvii., page 305) how easily a convergent nozzle may be made to give an excess discharge by the simple expedient of adding a diverging tail. The usual theory states that maximum discharge is given for an exhaust pressure

$$p_m = p_0 \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}} \quad . \quad . \quad . \quad (5)$$

This assumes that "n" is known or else the ratio of $\frac{p_m}{p_0}$ must be found by experiment. Now, every nozzle tends to a maximum discharge, and that maximum can always be obtained by allowing the depression effect full play. Excess discharge can be obtained for all super-critical back pressures down to a value p_d found from

$$p_m = p_0 \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$$

and

$$\frac{n}{n-1} \quad (p_0 V_0 - p_d V_d) = (p_d - p_m)\, V_m \quad . \quad . \quad (6)$$

where $p_d > p_m$,

provided that a tail piece be added to allow the depression to be set up. A lower value of back pressure (*i.e.*, less than p_d) will not give a discharge greater than the usual theory demands, but will give that discharge with a lower depression below p_m. In the foregoing, the term "discharge" means discharge calculated on the super-critical back pressure. It does not appear that the depression effect will give an explanation of the observed excess of the maximum theoretical discharge noticed with the flow of saturated steam, unless depression enables a *vena contracta* to be formed with a displacement backwards of the theoretical minimum area with consequent enlargement. This would entail a similar excess in the case of all other gases, and the balance of experimental evidence appears to be against such excesses.

Effect of Depression on Oscillatory Flow.

An examination of Fig. 1 shows that at any pressure below p_1 there is always an excess of energy above that required for self-compression. Therefore,

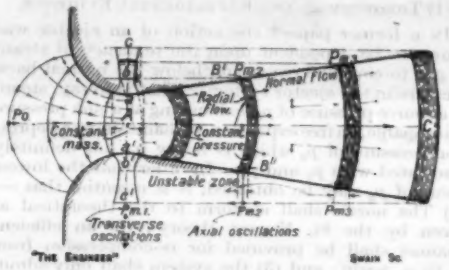


FIG. 3

if any disturbing factor be introduced, oscillatory action may be induced. An interesting speculation as to the incidence of such action may be made. The usual theory states that a critical pressure exists, expression (5), for the main nozzle, the area being a minimum at that pressure. In other words, the areas of flow rapidly decrease and then rapidly increase, passing through a minimum. Let it be assumed that while the flow, as a whole, is under constant pressure conditions, part of the flow which may be termed "radial flow," is under constant mass conditions, the initial pressure for the diverging portion of the nozzle being p_m and the final being p_3 the exhaust pressure. It will be seen from Fig. 3 that the natural time of radial outflow from A to C must equal the axial time of flow for free expansion. If the divergence be too great the steam cannot expand radially quickly enough to maintain contact with the walls. If, now,

the expression $\frac{p_m v_m - p_3 v_3}{n-1}$ = radial energy be used for determining the radial velocity and the mass flow being constant by assumption, then a minimum area of radial flow will be obtained at a pressure given by

$$p_{m_2} = p_{m_1} \cdot \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}},$$

In this case the area is the peripheral area between two constant pressure lines enclosing the assumed

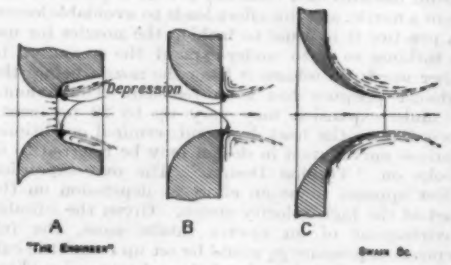


FIG. 4

constant mass shown shaded in Fig. 3. The radial velocity is zero at all points on the nozzle axis and a maximum at the boundary wall. A diagrammatic view of a radial flow nozzle is given in Fig. 3, the constant mass section planes moving together until p_{m_2} is reached at $b\,b^1$ and then separating to the outlet conditions at $c\,c^1$. The area at $b\,b^1$ is a region of unstable flow, the actual position being at B^1, B, B^{11} in the nozzle proper. At this section oscillations may occur, under the assumed conditions, the oscillations being in an axial direction, unlike those at the throat pressure p_{m_1}, which are transverse. If the assumptions underlying the radial flow be accepted, it follows that a series of critical pressures exist in a flow from p_0 pressure.

$$p_{m_1} = p_0 \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}} = p_0\,B.$$

$$p_{m_2} = p_{m_1}B = p_0\,B^2.$$

$$p_{m_3} = p_{m_2}B = p_0\,B^3.$$

$$p_{m_n} = p_{m_{(n-1)}}B = p_0\,B^n \quad . \quad (8)$$

and oscillations that may occur are transverse to the nozzle axis for odd indices of B and along the axis for even indices. A nozzle with correct divergence for the value of n exhibits no tendency to induce oscillatory flow, but if the form is incorrect depression can occur with subsequent disturbances. The assumed critical pressures are shown dotted in Fig. 2, and it would appear that oscillations are more pronounced in the lower pressure regions than in the upper, where critical pressures are farther apart. It is quite possible for a succeeding system of oscillations to damp out a preceding set, and this appears to be the case with curve J. The curves of unstable motion are not calculated, but sketched in at the points where likely to occur at critical pressures.

Nozzle Exit Forms for Least Depression.

Fig. 4 shows three forms of converging nozzles. A is a type that may be expected to show a fairly pronounced depression effect on account of the restriction of inflow, while B, between parallel walls, is an improvement, but is still likely to show an effect; C is the best form with curved outer walls, so that the external medium flows evenly into the jet on exit, thus preventing any appreciable depression.

SIXTY YEARS AGO.

In our issue of December 25th, 1863, it was recorded that at Small Heath, Birmingham, there had been growing up within the preceding year or so "a large manufactory which is destined to be the forerunner of a vast revolution in the gun trade." The factory in question was that, of course, of the Birmingham Small Arms Company. It was designed from the start to be self-contained, even the tools being made on the premises. In this establishment the writer of the article saw "the germ of a system which has for its object the complete abolition of the old plan of giving out work to be done by the workmen at their own private workshops." The works were being arranged on the system adopted by the American armouries and copied in this country in the already existing establishment at Enfield and in the works of the London Armoury Company. The keynotes of that system were the adoption of mechanical processes of manufacture at every possible stage, and of interchangeability among the parts produced. The first-named factor, it was argued, dispensed with the necessity for the employment of skilled workers, and would render strikes, if not altogether powerless, at least a kind of weapon chiefly dangerous to the users thereof. As regarded interchangeability, we read that the advantages of the principle had been demonstrated in a remarkable manner during the progress of the American War. "Ruined arms on the battle field," it is recorded, "have been gathered together and new guns formed of their parts—a stockless barrel and a barrelless stock making a second perfect rifle." It was said that but for the adoption of this method it would have been impossible to obtain small arms enough to supply the troops. . . . Elsewhere in the same issue we recorded the death, at the age of sixty-five, of Mr. John Hetherington, of the Vulcan Works, Manchester. Mr. Hetherington, it was stated, had contributed largely in his time to the practical improvement of many classes of machinery. Among his inventions was "the two-flued boiler, now so extensively used in Lancashire and elsewhere." He was also, it was claimed, the first to introduce plate moulding "as at present practised." . . . In an article entitled "Rolling Stock and its Maintenance," it was stated that the number of railway vehicles in the United Kingdom was approximately 219,500, and that the annual cost of repairing and renewing them was £1,242,714, or about 8¾ per cent. of the total expenditure of the companies. Criticism of this expenditure was expressed, and it was urged that it might be very considerably reduced, notably by lightening the construction of the trucks and carriages. It was argued that the average vehicle was probably a fourth heavier than it need be. The excessive weight, combined with the absence of buffers on many, or most, of the trucks, resulted in a series of "semi-collisions" every time a train started or stopped. It was chiefly in the underframes that the excessive weight occurred. These parts, it was stated, had to be made heavy because the road was bad, and the road was bad because the engines were too heavy for its powers of endurance.

There used to be an idea that a serious railway accident always occurred at Christmas; in fact, as recently as after the Hawes Junction accident on Christmas Eve of 1910, the *Manchester Guardian* in a leading article supported that opinion. Possibly the notion resulted from the terrible disaster at Shipton-on-Cherwell on Christmas Eve, 1874, when thirty-four passengers were killed as a consequence of a derailment due to a tire breaking under the leading vehicles. Then two years later—on December 21st, 1876—occurred the Holesley collision, where, despite perfect signalling and the block system, a down express ran into an up goods train which had been shunted on to the down line, killing four passengers; and in 1879, three days after Christmas, the Tay Bridge disaster, with its toll of many lives. Since then there have been only three really serious accidents at Christmas time. At Chelford on December 22nd, 1894, a truck had been blown by a high wind out of a siding without the signalman's knowledge. Into it a goods train ran and threw the truck foul of an up express. Fourteen passengers were killed as a consequence of this collision. At Wivelsfield on December 23rd, 1899, the fog signalling arrangements broke down, which, coupled with what the Board of Trade inspector called "the apathy" of a station master, a ganger and a signalman, together with the driver of one express failing to work to rule, brought two expresses into collision, in which five passengers were killed. At Hawes Junction on December 24th, 1910, an express caught up and ran into two light engines, which the signalman had forgotten. Nine passengers were killed here, and there was a bad case of fire in the *débris*.

Railway Matters.

THE provision of up and down relief lines, each 3 miles 51 chains in length, in the neighbourhood of Yatton, sanctioned in 1913, but deferred owing to the war, is to be proceeded with. The object is to improve the facilities between Bristol and the junction at Worle for Weston-super-Mare.

THE former Rhymney Railway at Cardiff is to be led by a junction into the former Taff Vale Station at Queen-street; Newport-road Station on the former line will then be closed. The station at Queen-street is to have a new platform, and the present down platform is to be made into one of island shape.

REVISED editions of the official railway maps of England and Wales and of Scotland, on a scale of 7½ miles to 1in., issued by the Railway Clearing House, have been prepared and copies are now available. They give effect to the alterations consequent upon grouping. A new map of South Yorkshire, on a 2 mile scale, has also been made.

THE Great Eastern section of the London and North-Eastern Railway is to be used for mineral traffic from the Notts. and Derby district *viâ* Peterboro' as it is used *viâ* Doncaster and Spalding for coal from South Yorkshire. It is interesting to remember that when the affairs of the Midland Railway were in the keeping of George Hudson, one of the reasons he had for the construction of the Syston and Peterboro' branch of the Midland was to give communication between that system and the Eastern Counties—later the Great Eastern—of which also he was the chairman.

THE directors of the London, Midland and Scottish Railway Company have approved an arrangement for lending money on favourable terms to members of the staff, in any rank, who are desirous of purchasing or erecting houses for their own occupation. The main principles of the scheme are:—A loan up to 90 per cent. of the railway company's surveyor's valuation of the property to be purchased or built; an interest charged on the loan at the rate of 4 per cent. per annum; repayment of the amount of the loan and the interest thereon, in equal instalments, by deductions from salary or wage, spread over ten, fifteen or twenty years.

THE year ended June 30th last was a very successful one for the Queensland Government Railways. The net earnings were £706,138, as compared with £344,168 for 1921–22 and £230,914 for 1920–21. The earnings per mile open were £923.74, as against £891.23 and £920.89, and the operating ratio was 86.97 per cent., as compared with 93.32 per cent. and 95.63 per cent. These better results were made possible by reducing the expenditure by £96,100—from £4,810,362 to £4,714,262. This was mainly due to the less payments for coal, as it is now obtained from the Bowen coalfield by means of a railway, 49 miles in length, from Merinda. The interest on the cost of constructing this line has been more than recouped by the saving in fuel.

AN incident at Ivybridge in December, 1908, when the distant signal failed to go to the "on" position and a following train found the stop signals at "danger" but the distant at "clear," led to the Great Western interlinking the position of the distant signal with the block instruments. This arrangement prevents "line clear" being given should the distant not be fully "on." It is particularly useful at stations where carriages are slipped, as there the distant indication is very important, since the slip must not be made unless the distant be "off." The Great Western has just provided such interlinking at Hatton for the distant signals for the up line at the three boxes there. At two of the boxes the up distant signals are to be operated electrically.

THE blue-book on railway accidents which occurred during the three months ended March 31st contains twenty-five reports by Mr. Main on his inquiries into accidents to servants. Six of the reports relate to fatal cases which involved the death of eight men. None of these cases call for special criticism, unless it be that in which two men were drowned at Milford Haven. An engine, worked by the Milford Haven Dock and Railway Company, was returning from a trip, and, the shunter in charge having forgotten that he had been told that the swing bridge was about to be opened, ran into the dock. Four men were on the footplate, two of whom were drowned. The swing bridge is now protected by gates with red discs and lamps and by "stop" boards.

IN distinct contrast with our Railways Act the United States Transportation Act did not provide for compulsory amalgamation of the railways. The latter Act was based on Bills introduced by Senators Esch and Cummins respectively, and, though both favoured compulsion, that feature was not included in the Bill put forward by the Government which subsequently became the Transportation Act. It provided only permission for amalgamations in accordance with a plan to be drawn up by the Inter-State Commerce Commission. Senator Cummins has now become Chairman of the Senate Committee on Inter-State Commerce, and has announced his intention to introduce a Bill to provide for compulsory consolidations after a period of seven years has expired. Meanwhile voluntary agreements may continue, subject, as at present, to the approval of the Commission.

THE parliamentary plans for the work for which the Southern Railway is seeking powers are now available. They show that the Wimbledon and Sutton Railway is to begin with junctions with the line from East Putney, over which the District trains run, and with the main line from Waterloo, and is to join the Brighton section on the west side of Sutton Station. At Leatherhead a junction is to be laid in on the west side of the Brighton station there and join the South-Western line on the west side of the South-Western station. Trains for Horsham on the Brighton section and for Guildford on the South-Western section will then both use the former station, and allow for the latter to be closed. A curve, which will rise and join the South-Eastern section in an easterly direction and give access to Reigate, Redhill, &c., is to be laid in from the west end of the Brighton station at Dorking.

Notes and Memoranda.

DURING some excavating work at Shawinigan Falls, Quebec, a number of blasting holes were put down in granite, with pneumatic drills, at an average rate of 9.4ft. per hour. The holes were from 12ft. to 22ft. deep and were started at 2¼in. in diameter.

THE new crushing plant of the West Springs gold mine, Transvaal, will have an initial capacity of 40,000 tons a month, but there will be provision for considerable expansion. The crushing equipment will consist of gyratory crushers, and it is not proposed to employ secondary crushers, although provision will be made for the installation of other plant at a later date should it be demonstrated that the employment of two-stage crushing will be required.

UP to the end of August, private motor carriages and motor cycles taxed on the horse-power basis contributed nearly £7,000,000 to the Road Fund, as compared with something well under £5,000,000 from the commercial and hackney carriage motor vehicles. Nearly £2,000,000 more was realised from private cars alone than in 1922, and each year a similar numerical increase can, apparently, be looked for. Roughly, there is an increase of 70,000 cars on the road each year.

IT is reported from Stockholm that the Swedish engineer, M. Cornelius, has invented a new type of furnace called the electro-thermic accumulator furnace, by means of which it is possible to control the heating of metals, especially iron and steel, to any degree desired up to 1300 deg. Cent. The invention is also said to have solved the problem of the electrical manufacture of uncoloured window glass. A six weeks' trial made with the furnace at the Stridsberg and Bjoerk workshops at Trollhaettan is stated to have yielded extremely good results.

ACCORDING to a report issued by the Dominion Bureau of Statistics, the October output of pig iron in Canada showed a slight decline to 73,598 gross tons as compared with 75,216 tons produced in September. The average monthly production for the ten months ending October this year was 76,000 tons, and the total production during this period of 758,194 tons showed an increase of 142 per cent. and 50 per cent. over the outputs in the corresponding periods of 1922 and 1921, when the quantities produced were 312,877 tons and 506,730 tons respectively.

THE returns of the National Federation of Iron and Steel Manufacturers show that the production of pig iron in November amounted to 597,600 tons, compared with 595,700 tons in October and 493,900 tons in November, 1922. The furnaces in blast at the end of the month numbered 199, an increase of 10 during the month. The total includes 184,100 tons of hematite, 204,000 tons of basic, 152,400 tons of foundry, and 26,100 tons of forge pig iron. The output of steel ingots and castings amounted to 749,500 tons, compared with 702,200 tons in October and 600,800 tons in November, 1922.

IT is estimated that in the United States to-day there are about 350,000,000 incandescent lamps, the number of which is increasing at the rate of about 10 per cent. per year. The annual demand for new lamps and renewals is approximately 200,000,000, exclusive of miniature lamps. The use of incandescent lamps in all the other countries of the world combined is about equivalent to that in the United States. The average candle-power has increased from 16, which prevailed about 1905, to over 60. The average number of watts consumed per lamp, however, has remained practically stationary at about 55. This shows that the present lamp has about four times the efficiency of that of 18 years ago.

AN X-ray invention has been made by Dr. Holt and Dr. Bouwers, of Amsterdam. It consists of a new tube which projects a powerful beam of X-rays; in fact, the tube itself is very similar in appearance to a large electric torch. No X-rays emerge from the tube except in the beam, with the highly important result that there can be no danger to the operator. The stream of negative electrons is caused by means of a tiny filament heated to incandescence by an electric current, and this draws rays from the positive anode of the tube in a finely focussed pencil. The rays can be directed on any local spot for treatment with the greatest ease, as, in spite of the high pressure, the tube can be held quite safely in the hand.

AT an informal meeting of the Institution of Electrical Engineers held on December 3rd, Mr. C. M. R. Balbi opened a discussion on "Electrical Aids for the Deaf." The large gathering contained a number of visitors from the Royal Society of Medicine, several of whom discussed the practitioner's experiences. Mr. Balbi defined deafness as sub-normal hearing, and said it was of two natures: deafness of the outer ear, which could be cured or aided in 90 per cent. of cases, and deafness of the inner ear, which was beyond all known aids. Lantern slides showed the structure of the ear with its series of diaphragms and connections, and he exhibited a few pieces of apparatus designed to aid the deaf, and explained the need for providing indications of the direction of sounds.

AT a recent demonstration of very high voltages given at the laboratory of the American Westinghouse Electric and Manufacturing Company, a 42ft. arc at a potential of 1,000,000 volts was formed. This is said to be the largest controlled arc ever made artificially. It was followed by a demonstration of the efficiency of the horn gap. A 15ft. horn was constructed, and an arc was induced at a potential of 200,000 volts. The arc rose slowly, owing to the hot air produced, with a tearing noise, to the end of the horn, blew out and immediately re-established at the base. It rose again and again until the circuit was opened. This self-extinguishing feature is, of course, used daily on the power systems to relieve surges and lightning strokes. Tests of insulator flash-overs were also made. In these tests a dry insulator post, built up of several units, was flashed over at a potential of 800,000 volts. It was then covered with a heavy water spray to simulate conditions during a torrential rainstorm, and it flashed over at a potential of 650,000 volts, showing the wet insulator to be 75 per cent. as efficient as the dry insulator.

Miscellanea.

WORK is to be started very shortly, by the Garswood Hall Colliery Company, on a new boring in the Maryport district.

THE Bethlehem, South Africa, municipal authorities have decided to expend £30,000 on a new water supply scheme.

THE Yorkton, Saskatchewan, Town Council proposes to expend 33,000 dollars on improving the local electric lighting and power system.

THE output of the coal mines of Great Britain for the week ending on December 15th was 5,947,900 tons as compared with 5,741,600 tons for the corresponding week of last year.

WITH the re-kindling of two more blast-furnaces at the Normanby Ironworks, Middlesbrough, the number of furnaces in operation on the North-East Coast has been increased to 48, as against 70 in normal times.

WIRELESS telephonic communication between Nice and Hartford, in Canada, over a distance of 3100 miles, has, it is reported, been successfully established on a wave length of only 100 m., instead of 200 usually used.

THE Disposal and Liquidation Commission has decided to realise by public auction at an early date the whole of the real estate of the Government factory at Gretna. The sale, it is expected, will be held next spring.

THE production of lumber in British Columbia for the first eight months of 1923 was 20 per cent. higher than the best previous record. This will easily be the best year in the history of the lumber industry in the Province.

THE United States Government has again approached Canada as to the negotiation of a treaty which would permit of the construction of a deep waterway from the Great Lakes to the Atlantic by way of the St. Lawrence River.

THERE were 12,542 patents issued by the Canadian Dominion Patent Office in the last fiscal year, the greatest number in one year. This is 70 per cent. more than the previous year, according to the report issued by the Commissioner of Patents.

A BILL is to be deposited immediately for introduction into Parliament next session, the object of which is to facilitate the drainage of certain coalfields and mines in the West and East Ridings, and in the Counties of Nottingham, Derby and Lincoln.

THE Fifth Brussels—International—Commercial Fair, is to be held from April 1st to 16th next year. The growth of the Fair since its inception in 1920 is well illustrated by the fact that in that year the space occupied by exhibitors was 19,419 square metres, whereas in 1924 three halls, covering 50,000 square metres, will be used.

DURING November only 97 tons of coal were imported into Switzerland from Germany, while 48,445 tons came from the Saar district, 43,564 tons from France, 11,161 from Belgium, and 8712 tons from Great Britain. The total supply from all sources during the month was 131,751 tons of coal, about 43,000 tons of coke, and 26,000 tons of briquettes.

THE dredging now going on at the First Narrows, Vancouver Harbour, will deepen the channel to 36ft. at low tide and widen it to 1200ft. instead of 900ft. This will mean that the tide rip will be reduced to 4½ knots. Minor improvements under way include additional elevator accommodation and the building of a grain jetty to increase the delivery capacity of the elevators.

THE output of Portland cement in the United States in October broke all records for a single month. The total production for the month was 13,350,000 barrels compared with 13,100,000 in September, and less than 12,300,000 a year ago. For the ten months ending October 31st, over 114,000,000 barrels were produced, exceeding last year's record output for the same period by 20,000,000 barrels or 22 per cent.

DURING 1922 the United States imported pig iron and ferro-alloys to the amount of 455,469 tons, of which 383,445 tons were pig iron. On the other hand, their exports of this material during the same period amounted to no more than 30,922 tons. The average rate of imports has increased, for during the first four months of 1923 the United States received 228,443 tons of pig iron. Up to the present England has been the principal supplier.

A COMMITTEE of the Federation of British Industries, which has been inquiring into central and local taxation, has published some striking figures in support of its contention that the increase in recent years has imposed a severe handicap on industry. It specially states that the rating of machinery intensifies the burden and accentuates the inequality between industrialists and other ratepayers, and urges that legislation on this question is urgently required.

THE production of gold in Ontario during the third quarter of 1923 was at the rate of 95,566 oz. per month. For the nine months from January 1st to September 30th, gold production showed a slight decrease as compared with the corresponding period of 1922. This decline was caused by the power shortage in the earlier months of the year, and if production for the final three months of the year equals that during the three months to September 30th, the full year 1923 should show an output of over 21,000,000 dollars as compared with 20,674,109 in 1922. The total output of silver shows an increase of over a million ounces.

PRIVATE interests have offered, according to the *Canadian Engineer*, to take over from the Ontario and Federal Governments the peat plant at Alfred, Ontario, and to operate it on a commercial basis. No cash consideration is involved, the company merely stepping in to take charge of the plant, giving guarantees that the plant will be operated and the fuel distributed in the surrounding district. The Alfred plant is not at present in operation, but all the machinery and equipment which, by the arrangement now being consummated by the two governments, is under cover and will be handed over with property rights to its new owners,

THE VERMOT SHUNTING TRACTOR

USINES DE CONSTRUCTIONS MECANIQUES DE VILLEFRANCHE-SUR-SAONE, ENGINEERS

(*For description see page 687*)

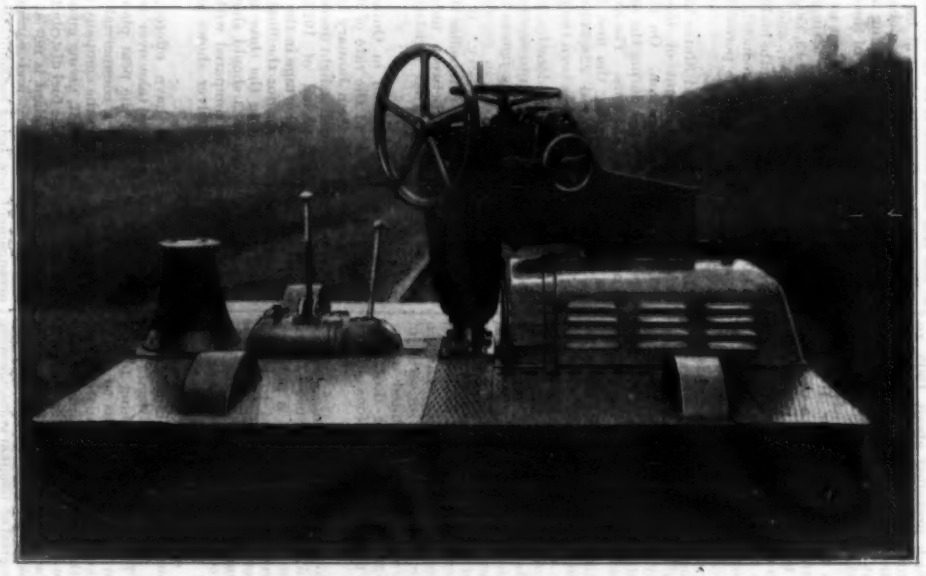


FIG. 3—END VIEW OF THE TRACTOR

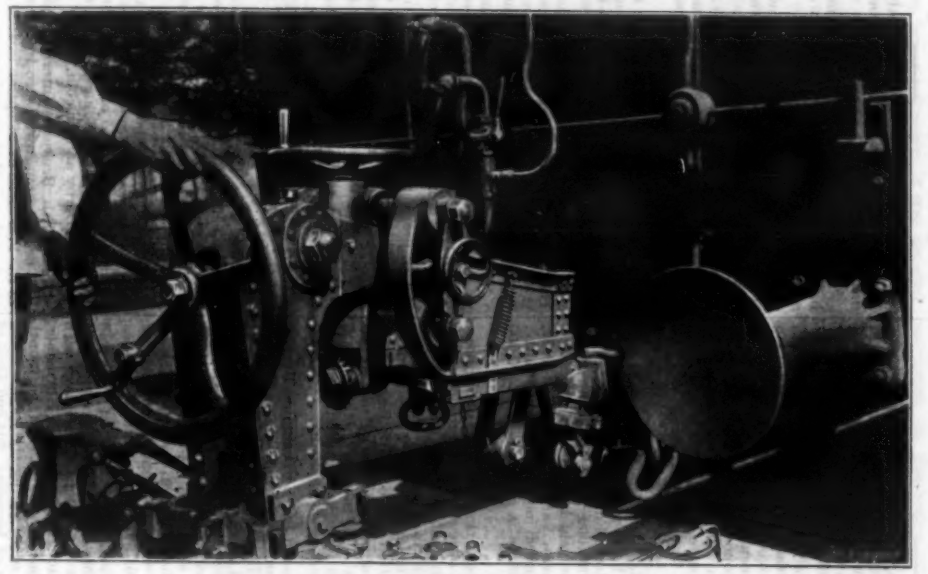


FIG. 4—ATTACHING THE TRACTOR TO A VEHICLE

FIG. 5—THE TRACTOR ABOUT TO HAUL A TRAIN

FIG. 6—CAPSTAN HAULING WAGONS

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The Engineer

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By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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THE ENGINEER.

DECEMBER 28, 1923.

Powdered Fuel.

THE Institution of Electrical Engineers has no objection to its meetings being used for advertising purposes. It is not our present purpose to discuss the desirability of that course. It has its advantages and its drawbacks. We may safely presume that the Council of the Institution has balanced the two and found that the former outweighs the latter. The chief drawback is perhaps that papers with "ulterior motives" lack some of that strict impartiality which is the aim of scientific people. We do not expect a searching inquiry into both sides of a case by an author who is "interested" in one side only. That is not a very serious defect when the paper is presented to technical men, who are at perfect liberty to cut it to ribbons or to advance the merits of their own wares. Papers before the "Electricals" are frequently presented at a large number of centres, and it is probable that the statements of any author are very thoroughly winnowed and sifted before his tour of the provinces is completed. The main defect, as we have said, is that such papers are not scientifically impartial. We cannot accept the statements in them without some measure of reserve; we cannot quote from them without acknowledging that they are *ex parte*; we cannot use the figures presented in them in our own affairs with unhesitating confidence. They may be accurate, but equally they may be coloured by the businesslike optimism of an author who has something to sell. A little guardedness in respect to them is right and proper.

It is necessary to bear this aspect of the matter in mind when we are considering such papers as that read before the "Electricals" in London last week and to be presented, we understand, before a dozen or more branches during the next month or two. The author, Mr. David Brownlie, attracted a great deal of attention some years ago by a searching and valuable examination of the general efficiency of boilers and boiler plants in this country. But he is no longer the independent scientific observer that he used to be. He is nowadays engaged in pushing an American system of firing steam generators with powdered coal, and for that purpose he has been primed with American "facts." We do not know whether those facts may be taken without reserve; we do not know if the observations are absolutely comparable with those made by the British method of measuring boiler efficiencies and outputs. Mr. Brownlie himself says that the existing British code for boiler testing is defective and that it differs from the American code, which he considers better, yet open to improvement. Clearly, as long as differences in the methods of measurement exist, differences in results are likely to be attained. American makers of air compressors, to take a parallel example, secure efficiencies which our makers cannot reach. But the difference is not in the machines. It is in the methods of measurement. That is a question that will have to be settled some day in fairness to British makers. An international code for such tests is needed and an international code for boiler testing is equally necessary. The Institution of Civil Engineers is responsible for our existing code, and we agree fully with Mr. Brownlie that it is time it was revised if for no other reason than because the Americans have been busy for a long time working out a new code of their own, and if we delay action too long we shall find their code made international even though it does not suit us. It is interesting to review the discussion bearing this aspect—that American and British practice are not strictly comparable—in mind. Sir James Kemnal, whose experience on both sides of the Atlantic is unsurpassed, asked the meeting to remember that British and American coals are dissimilar. The latter is more friable than the former. Mr. G. W. Partridge confirmed Sir James Kemnal's remarks. Then Mr. Pochobradski said quite bluntly that the difference in the efficiencies of the Lakeside (powdered fuel) and Dalmarnock (mechanical stokers) stations was due, not to the method of firing, but to the difference in the working conditions. The coal used in the American station was drier than that used in the Scottish station, and the gases left the former at 205 deg. Fah., against the 414 deg. Fah. at the latter. Making corrections of this nature, to bring the two systems into line, he found that the Dalmarnock boilers, on test, could give an efficiency of from 85 to 86 per cent., against the Lakeside figures of 87 per cent. Mr. David Wilson took the same view. He held that to make comparisons between stations not working under similar conditions and not equally scientifically operated was to cloud the issue. The figures given by Mr. Brownlie for Lakeside were test figures, those for Dalmarnock running figures. All these observations point to the fact that we must not be carried off our feet by the reports upon powdered fuel, and that until strictly comparable results are obtainable it would be unwise to say that it has the superlative merits which it appears to have, or that the merits which it has proved in America with American coal and American conditions would obtain in this country with its very different conditions. But if a desire for strict truth obliges us to look cautiously upon American claims for a powdered fuel system advanced for business purposes, in equal measure it requires us to weigh well the criticism of people who are interested in mechanical stokers. We have to steer an even course between these conflicting elements. Sooner or later the matter must be settled scientifically, and that brings us back again to the same point, that nothing short of strictly comparable tests can give us a final judgment. But we are by no means sure that a rigidly scientific balance can ever be effected. Probably in the long run it will be found that for very large boilers operating with a readily powdered fuel, a fuel that does not burn perfectly on a grate, the powdered fuel system is invariably the better, whilst for smaller boilers using coals of British quality, then the mechanical stoker holds the field. On the face of it, it seems improbable that it can ever be worth while to pulverise a coal that burns completely without that treatment.

In the meantime, whilst we are waiting for final and conclusive facts as to the thermal efficiency of powdered fuel, there are many purely practical questions to be dealt with. A good part of the discussion turned on the relative merits of central pulverising and "unit" pulverising. Another very interesting question and very important one is the disposal of ashes. With powdered fuel there are practically no ashes, but naturally no one claims that none are produced. What happens is that they are so exceedingly fine that they are carried up the chimney and spread over the face of the world. It is said that no one is able to find any trace of them and that no inconvenience results. If that be so, obviously the right course for our central stations to pursue is to avoid the great expense of ash removal and disposal by establishing a crushing plant near the boilers, comminuting the ashes and delivering them into the base of the chimney for removal by the draught and dispersion by the wind! A far less costly method than the present, but hardly likely in this country to meet with the sanction of the Ministry of

Health. Finally, the general economic efficiency of the stations instead of the thermal efficiency of the boilers must be studied. The object is to produce electricity for the smallest fraction of a penny. It has yet to be proved that powdered fuel enables us to do that. We may have to pay more for five per cent. more efficiency than that gain is worth. The capital cost, the maintenance cost of the powdered fuel plant and boilers, and the price of fuel are the controlling factors. The application of pulverised fuel burning, long known in the cement trade, to boilers is an extremely interesting matter, but a great many things have to be learnt about it before one can say that it is superior to other methods of burning coal, and we must certainly not be carried away by the few remarkable figures which have come to us from America.

Railway Labour.

THE award of the National Wages Board, issued on the 20th instant, cannot give the railway companies much satisfaction, for it is a rare event for them to come off second best. On some points—probably one-half—their claims have been allowed, but those on which they have failed are the more important. The former were: that the hours after midnight of a turn of duty that commences on Sunday night shall be paid at ordinary and not time-and-a-half rates; that the payment of half a day at the Sunday rate to a man who comes on duty for a short turn and of a full day to a man who comes on duty twice, or works longer than three hours on a single turn, is an arrangement "which it would not be unreasonable to modify;" that the basis for enginemen paid by mileage should be 150 and not 120 miles; that the fifteen minutes given to enginemen to dispose of their engines should be reduced to ten minutes for drivers and entirely withdrawn from firemen. The claims advanced by the companies and rejected by the award included: that double pay given to certain grades—all in the permanent way, signal, and telegraph departments—for Sunday duty, because it "is heavier than that which constitutes the normal duties of the men, and that it is sometimes done under conditions of urgency and stress which call for special continuity of effort," should be at time and a-half; that work done between 10 p.m. and 4 a.m. on other nights than Sunday should be at ordinary rates and not time and a-quarter; that the remaining war bonus should be entirely withdrawn and the sliding scale arrangements be cancelled as soon as the cost of living index figure reaches 70 points above pre-war level. In submitting their case the companies did not plead poverty, but urged, to quote the award, "the importance, the great importance, in the national interests, of bringing the wages and other conditions of railwaymen more nearly in conformity with the wages and other conditions in industry generally." It may be added that had all the claims been conceded the savings would, it was estimated, amount to 3¼ million pounds a year. The National Union of Railwaymen has accepted the award, but the Associated Society of Locomotive Engineers and Firemen is taking a ballot on the question. There has been quite an unnecessary alarm at the latter step; it has always been safe to count on the Associated Society doing the very opposite to the National Union.

It may be considered appropriate if, on this occasion, without departing from our attitude as to political questions, we refer to the possibility of British railways being nationalised under a possible Labour Government. That mines, railways, and other public utilities would be threatened with nationalisation were Labour in power, in such strength as to be independent of the other political parties, is safe prophecy. At one time Labour could have relied, were such a proposal under consideration, upon great support from members of the Liberal Party and even from a few Conservatives. But support from such quarters is far less likely than it was. There are now, except among the Labour members, few enthusiasts for State ownership of railways. Government control during the war killed it, both here and in the United States. Actually, all over the world State ownership of railways is at a discount. In a leading article in our issue of October 5th last we showed that private ownership had again come about in Austria and Italy and that the railways of Belgium were to be conducted on business principles. What happened only a fortnight ago in Ireland is a most instructive lesson in this matter. A Committee, appointed by the Provisional Government that preceded the present Free State Government, recommended Government ownership of the railways in the Free State, but not their operation. The Government threw this recommendation over and brought in a Bill to continue private ownership, but with complete amalgamation. The Labour members brought in a Bill, too, but for nationalisation. It, however, was rejected by 56 votes to 16. Frankly, we cannot imagine that British railways will ever be nationalised even by a Labour Government. Not only is the greater portion of public opinion against it, but the men, as we shall show directly, are uncommonly well off in their existing relations with the companies. What we consider a greater danger is that the companies may not see their way to carry on. There was a period a year or so before the war when the situation was very disheartening and when a large number of the directors and officers would have welcomed nationalisation as a solution for their troubles. Financially the shareholders would be as well off, whilst the directors and those officers who were dispensed with would receive compensation as in the Railways Act. That Act gives the companies certain benefits. It, for instance, aims at obtaining for them a certain rate of return. But that rate is contingent on other things, and when the net profits reach the figure aimed at other factors come into play. Thus, what with one thing and another, the benefits given to the companies by this Act are more apparent than real. Added to all this there now come, to add to the loss of traffic through valuable consignments being carried throughout, from factory to warehouse, by motors, the proposed motor ways between the large centres. From these indications it seems that there is a greater risk of railway nationalisation being urged as a result of a movement from within than from it being carried by a Labour Government. If that danger is to be averted the companies must be supported by traders and the public.

The amicable settlement of the present matter carries on an excellent record. For over twelve years now there has not been a single point of acute dispute between the companies and the men generally. The strike of September–October, 1919, was directed at the Government, and the sectional one of the following February arose through the Government failing to ask the companies to set up the Committee which led to the National Agreement. The strike of August, 1911, caused the conciliation scheme to be amended and the unions to be recognised, and there has been little trouble since. As a further illustration of the happier relations between the two parties we would once more mention how the unions rejected the proposal of Sir Eric Geddes that they should have seats on the boards of management; they preferred instead the companies' offer to set up joint councils. The men as a whole are certainly satisfied with the award, and we do not believe for one minute that Mr. Bromley's section will cause trouble.

London Water Supply.

How few of the inhabitants of London realise the enormous size of the undertaking which supplies water to the Metropolis and surrounding districts. They may read in the newspapers from time to time that so many million gallons are supplied per day, but such figures mean little or nothing without some standard of comparison. We may say, for example, that a channel 10ft. wide by 2ft. deep and just over 1½ miles long would be required to contain one million gallons, and it would need the contents of nearly 250 such channels to satisfy the daily needs of the 6,900,000 odd consumers in the Metropolitan Water Board's area of supply. Even then no more than a vague conception of all that is involved in the water supply of a vast and extended city is attained. The average consumer does not stay to think where the water he uses comes from or what is done to it before it reaches him. He only really gives attention to the subject when he has to pay the water rate or when something goes wrong—a fitting leaks or a pipe freezes. To him, a perusal of the annual reports of the Metropolitan Water Board would indeed be an object lesson, and would enable him to form some sort of conception of the wide scope of the operations necessary for the supply of pure and wholesome water to such a vast aggregation of persons as is collected in and for many miles round the one square mile of the City.

We do not propose in the present instance to give a *résumé* of the report for the year ending March 31st last, which has just reached us; to do so would require far more space than can be spared in an article of this character. A few facts may, however, be of interest. To begin with, the statutory area supplied is no less than 563 sq. miles and contains an estimated population of over 6,900,000 persons, who are furnished with water through no fewer than nearly 1,147,000 separate services and through over 6600 miles of main pipes. On an average over 35 gallons of water are consumed by each person, the total daily quantity delivered being, at the present time, nearly 245,000,000 gallons per day. Of the total rather over three-fifths are derived from the Thames, just over one-fifth comes from the Lee, and somewhere about one-sixth is obtained from wells and other sources. We believe we are right in saying that every single gallon supplied domestically is pumped once at any rate, and much is pumped more than once. To do the pumping there are 276 main pumping engines with a combined horse-power of 43,967. Every drop of river water is filtered before it is allowed to enter the distribution mains, the total area of slow sand filter beds employed for the purpose being some 171 acres. To do its work the Board has to employ an army of very nearly 5000 persons, including a salaried staff of 800. Figures such as these might be multiplied almost without limit, but with them and with the statement that the capital indebtedness of the Board is in the neighbourhood of £53,000,000, enough has been said for our purpose. It will have been made quite clear that the business of providing London with water is of very considerable dimensions, and it can be said of it that the work is exceedingly well performed. The health statistics of the Metropolis show it to be most satisfactorily free from diseases which may be water borne, a fact, however, which is not astonishing to those who are acquainted with the meticulous care which is taken to ensure that none but water of the highest purity is sent into the distribution mains. In the days of the old Water Companies it was the pride of those responsible that no water with any taint to it every reached consumers' cisterns. The Water Board has upheld in this respect, as well as in others, the traditions of its predecessors.

We were always opposed to the formation of the Water Board, holding, as we did, the opinion that the old Water Companies were carrying out their functions satisfactorily and were more than capable of looking so far ahead that they would meet all demands that might be made on them. Nothing has occurred in any way to change that opinion, and our views on the question of the change are upheld in that we foresaw and foretold that, were it to be effected, the Londoner would have to pay more for his water without receiving any counterbalancing advantage. The consumer of to-day is no better off, though certainly he is no worse off, than was the consumer who was supplied by any one of the old companies; but the Water Board has undoubtedly achieved success by following absolutely in the steps of the Companies. Just before the Board was formed the London County Council, desiring to be the Water Authority of the Metropolitan County, sought hard for powers to acquire the undertakings of the Companies, with the avowed intention of abandoning the Thames and Lee as sources of supply and of going as far afield for water as the mountains of South Wales. The Board has from the very first refused to entertain the Welsh scheme on the ground that in the Thames and Lee Valleys and in the deep chalk wells which it owns it has ample resources for all time, providing adequate storage capacity is available Acting in accordance with that decision, it has systematically pursued the course originally mapped out by the Companies in constructing reservoirs in both valleys, first of all building those actually planned before it came into being, and th n designing one on its own account. At the moment the Board is possessed of storage reservoirs having a combined capacity of over 12,907,000,000 gallons of water available for domestic use. Had it not been for the war the huge Littleton reservoir would by now have been in service. When it is brought into commission the available storage will be more by 50 per cent. and will provide a standby capacity equal to more than eighty days' consumption without abstracting a drop of water from the rivers and without counting the amount—about one-sixth of the whole—which is obtained from deep wells. The ability to store large quantities of water has the incidental advantage of assisting in purification, and even before the adoption of sterilisation by chlorine, under the able direction of Sir A. C. Houston, London enjoyed a water supply second to none among the large cities of the world, despite the admittedly polluted nature of the major portion of its raw supplies. That blessing, we venture to predict, it will continue to enjoy as long as the existing methods of treatment are continued.

Mass Production of Railway Wagons.

OUR readers will remember that when we recently described the system of railway carriage building which has been evolved at the Derby works of the London, Midland and Scottish Railway, we referred briefly to the scheme, then in process of development, for the intensive production of goods wagons.

At that time, although the scheme was not fully organised, it was obvious that the principles involved were fully as interesting as those employed in the carriage department, and we were, therefore, pleased to receive an invitation from Mr. R. W. Reid, the carriage and wagon superintendent, to inspect the completed manufacturing equipment, which is, we believe, the most extensive of its kind in existence.

In this connection it should be pointed out that the works are essentially concerned only with the production of wood-framed vehicles. There may be factories where steel wagons are manufactured on the same general lines—we have the impression, in fact, that the principles adopted at the Ford motor car works, which somewhat resemble those employed at Derby, were originally and primarily worked out at an English wagon works—but up to now there has been little progress in the organisation of the works where wooden wagons are made. This state of affairs is, no doubt, accounted for by the fact that it is only now being brought home to the owners of woodworking mills that a mechanical engineer is really the man who should be at the head of any extensive works of this kind. Anyhow, there is no question that Mr. Reid, and his assistant, Mr. Lemon, have evolved a scheme for building wooden wagons which has resulted in a vast economy and enables the workmen to produce a very large output without serious bodily fatigue.

It might be asked why such pains have been taken to elaborate the production of a wooden article when metal construction might have been adopted with greater assurance of success—for it must be remembered that the Derby works are pioneers in this direction—but it should be borne in mind that the wooden wagon has the great merit of being comparatively easily repaired, in the event of accident, on the spot. If a steel wagon is involved in an accident, it has to be sent back to the shops for repair; but there are very few parts of this country where a new headstock or sole bar, for instance, cannot be fixed on a damaged wooden wagon without sending it more than a few miles.

The type of wagon on which attention is being concentrated at Derby just now is the 12-ton open, high-sided class, designed by the Clearing House, and weighing just over 6 tons empty. These vehicles are now being turned out at the rate of 87 per week, or one every half-hour, and since the new scheme was started, a little over three months ago, 1200 wagons have been produced. This output, Mr. Lemon told us, has already wiped out the capital cost of the new plant required by the scheme.

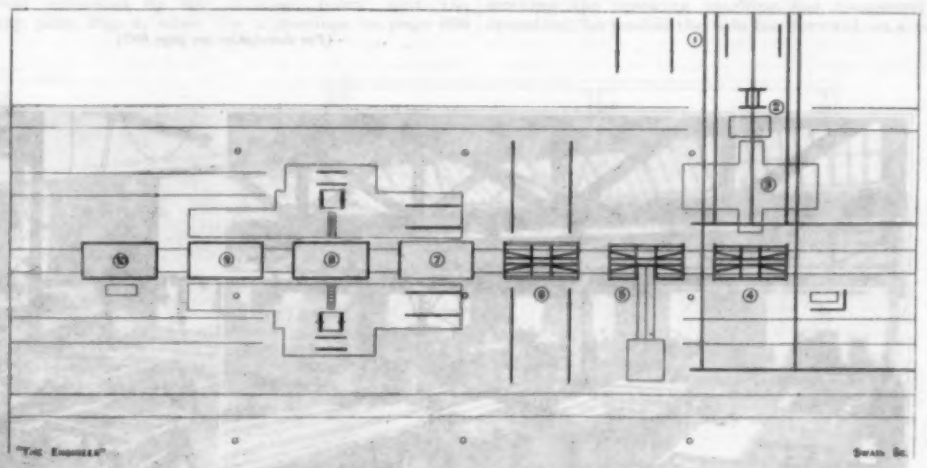
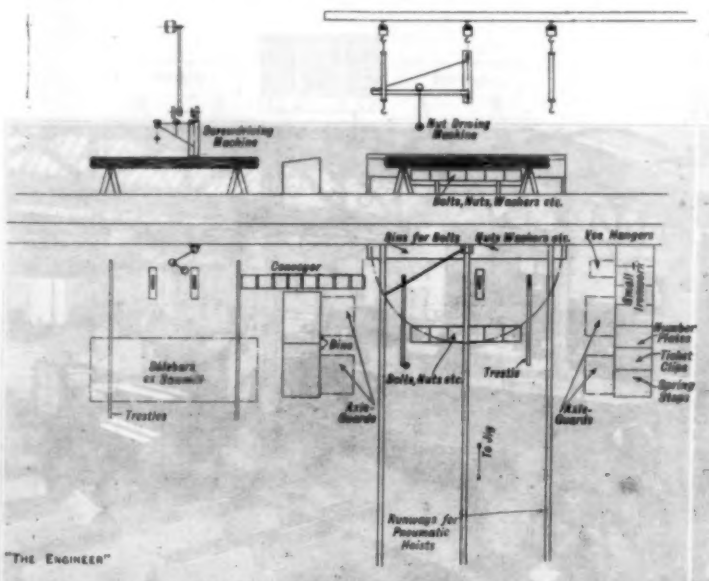
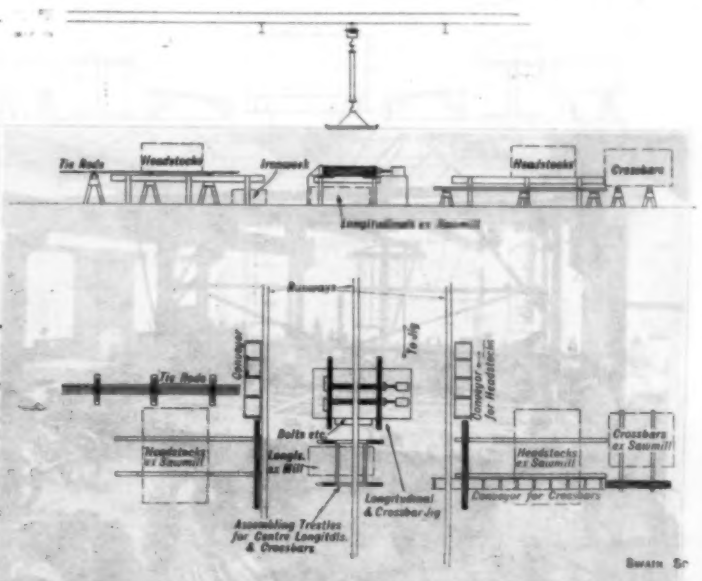


FIG. 1—KEY PLAN TO PROGRESS DIAGRAMS

FIG. 2—GENERAL VIEW OF ASSEMBLING BAY



OPERATION NO. 1—ASSEMBLING SOLE BARS



OPERATION NO. 2—ASSEMBLING HEADSTOCKS AND LONGITUDINALS

RAILWAY WAGON BUILDING AT DERBY—L.M.S. RAILWAY

(*For description see page 697*)

FIG. 3—GENERAL VIEW OF JIGS

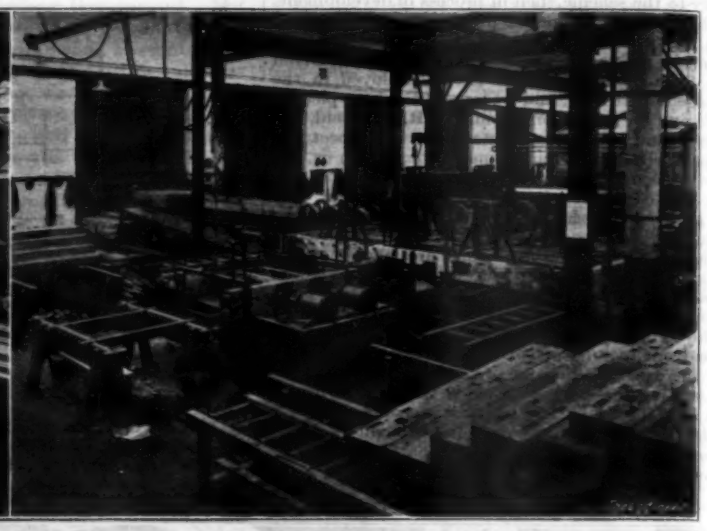


FIG. 4—ASSEMBLING CENTRES

FIG. 5—MAIN JIG

FIG. 6—TURNING FRAME OVER

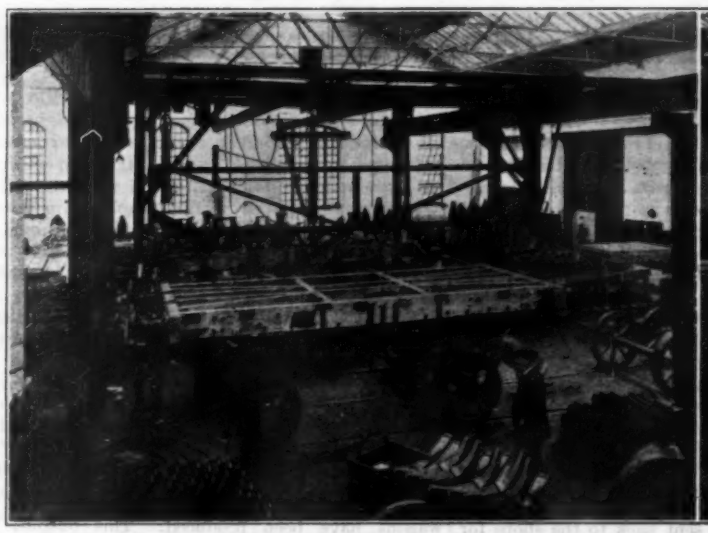


FIG. 7—LOWERING FRAME ON TO WHEELS

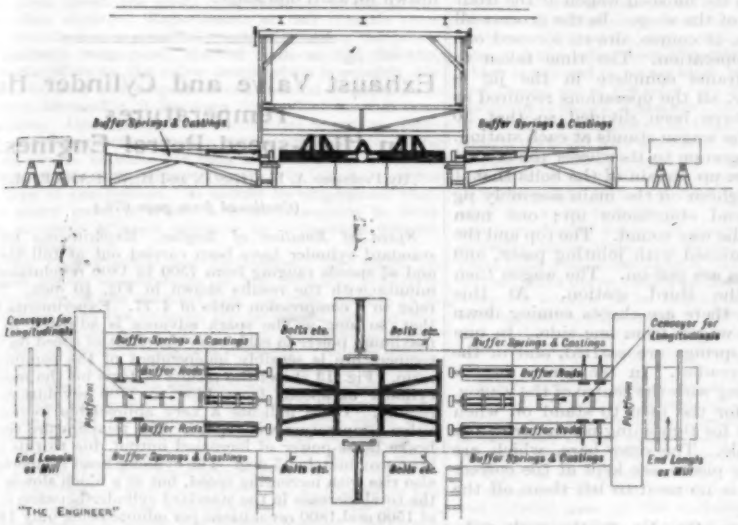
FIG. 8—FIXING CORNER PLATES

The wagon building department relies for its supplies of fashioned timber on the same saw mill as the carriage department, and as we have already described the methods adopted in the mill, it is not necessary to enlarge upon them here, but it is, of course, obvious that the parts of a wagon are not so complicated as those of a carriage, and they are prepared in a distinct part of the mill. After the various pieces have been checked over for dimensions, &c., in the mill, they are sent to the erecting shop on trucks drawn by electric tractors and distributed to the various parts of the shop where they will be required, and it is in this direction that the secret of success of the whole scheme lies. Every effort has been made to reduce to a minimum, the handling and lifting of material, which proceeds forward in an orderly manner, and is almost always kept on the level at which it will be ultimately required.

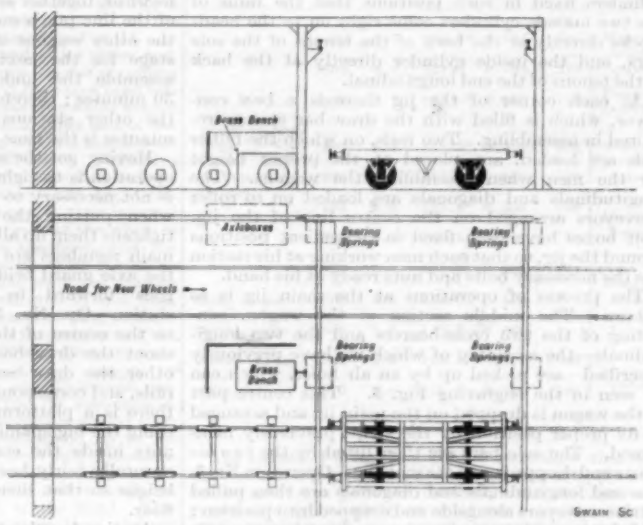
The erection of the wagons is carried out on a set of rails running across the shop, as shown in the engraving, Fig. 2, while some of the component parts are assembled in the adjacent bays. The process is split up into nine separate operations, which are best indicated by the sketches below, and the key plan, Fig. 1, while the engravings on page 698 help to illustrate the general scheme of operations.

One of the first processes is to fix the steel capping on to the sheeting planks, which is done at the end of the shop and gives continuous employment to a man working a screw-driving machine, similar to those we have already described in connection with the carriage building department.

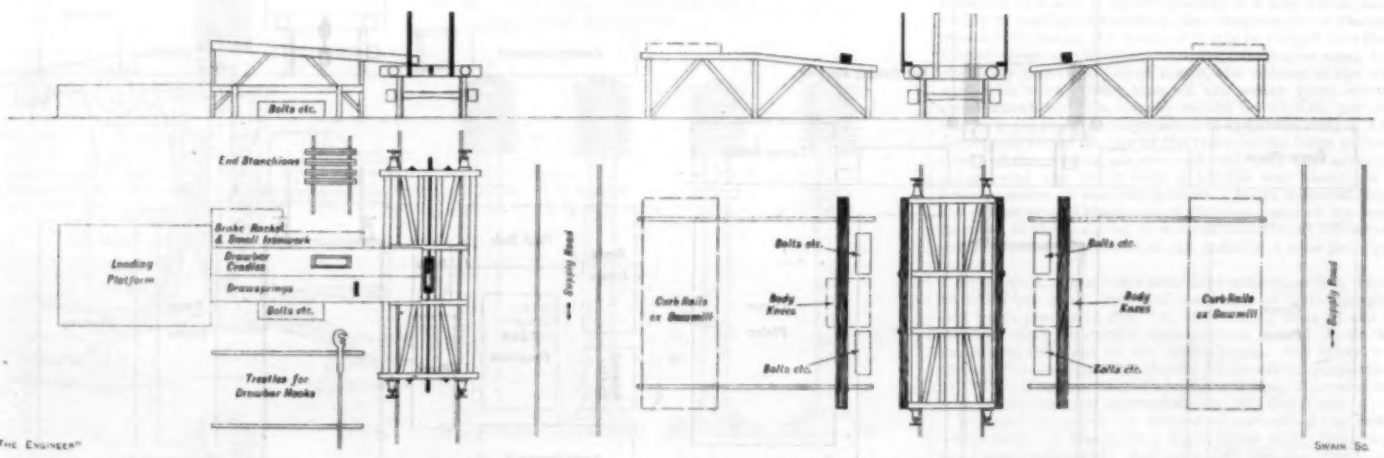
The next operation—see Fig. 3 and Operation No. 1—is the assembly of the sole bars when all the ironwork, such as axle guards, vee hangers, diagonal knees, strap bolts, &c., are put on to the sole bar, ready for assembly into the main frame. Overhead it will be noticed there is a small crane that carries a double-geared pneumatic drill, which is used for tightening the nuts on the bolts that hold the ironwork on to the sole bars. The sole bars are unloaded from the wagons on to trestles, which are at a convenient working height for the men. When the man working the screwing machine has completed his operation, he pushes the sole bar forward on a roller



OPERATION NO. 3—FRAME JIG AND TWO-TON CRANE

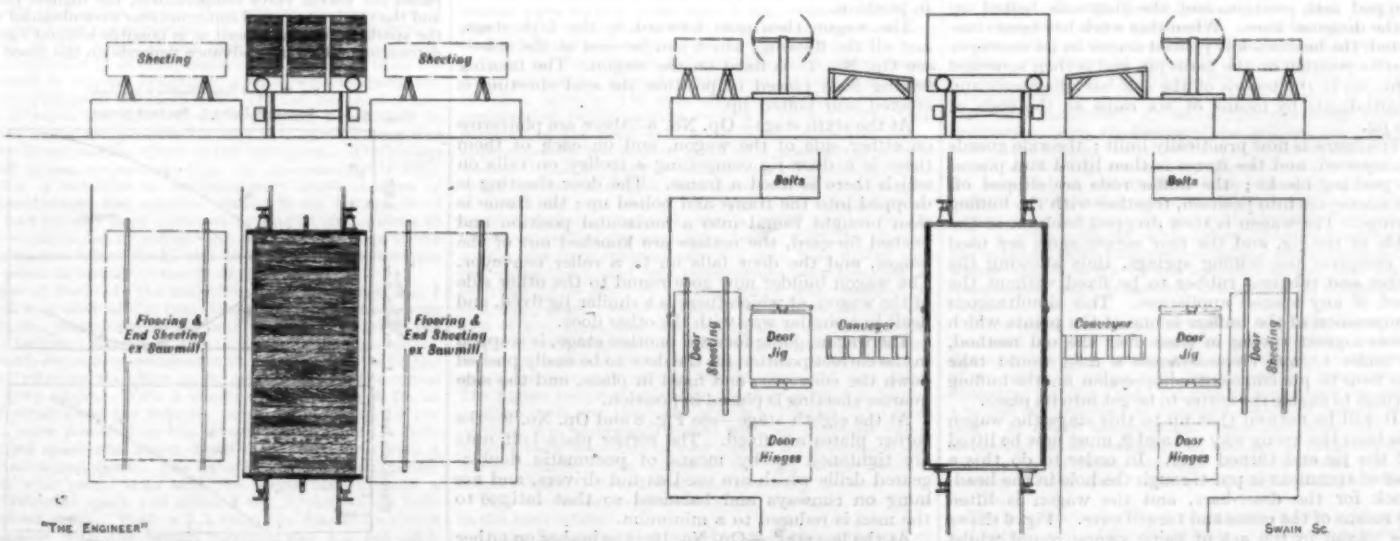


OPERATION NO. 4—WHEELING AND SPRINGING



OPERATION NO. 5—FIXING DRAW GEAR AND STANCHIONS

OPERATION NO. 6—FIXING CURB RAILS AND KNEES



OPERATION NO 7—LAYING FLOORING AND SHEETING

OPERATION NO. 8—FIXING QUARTERS AND DOORS

The next operation—see Fig. 4. It will be seen from Operation No. 2, that the through rods are at the correct height and in the correct position to be put through the holes that have been bored for them in the middle bearers. The safety loops, which can be seen in the engravings, are used as slings for lifting this middle section of the wagon and dropping it on to the main jig.

The main assembly jig—see Fig. 5—consists of a platform on which there is a number of strips

which fix the position of the middle bearer, longitudinals and sole bars in their relative position. Fixed on each side of the jig there is a hydraulic cylinder with a compensating lever arrangement for pushing the sole bars on to the middle bearer tenons. The ends of the jig have three hydraulic cylinders fixed in such positions that the rams of the two outside cylinders come right on to the headstocks directly at the back of the tenons of the sole bars, and the inside cylinder directly at the back of the tenons of the end longitudinal.

At each corner of the jig there is a box conveyor, which is filled with the draw-bar springs required in assembling. Two rails, on which the buffer rods are loaded, are placed at the proper height for the men when assembling the wagons. The longitudinals and diagonals are loaded on to roller conveyors arranged on the centre line of the jig. Bolt boxes have been fixed in convenient positions around the jig, so that each man working at his station has the necessary bolts and nuts ready at his hand.

The process of operations at the main jig is as follows:—The middle section of the wagon, consisting of the two cross-bearers and the two longitudinals—the assembly of which we have previously described—are picked up by an air hoist, which can be seen in the engraving Fig. 5. This centre part of the wagon is dropped on the main jig and arranged in its proper position by the strips previously mentioned. The sole bars are then lifted by the two air hoists and dropped on to the main jig—Operation No. 3. The end longitudinals and diagonals are then pulled off the conveyors alongside and dropped into position; and the two side rams come up and squeeze the sole bar on to the tenons of the middle bearers. The end rams are then brought up and, by means of a false headstock, which is dropped between the rams and different stations along the line on which the remaining operations are carried out. There are six stations, and they have been so arranged that there is an equal amount of time spent on each operation; it is, therefore, possible for the wagons, which are coupled together by a long stiff coupling to be drawn forward, together and the finished wagon at the front of the line taken out of the shop. In the process all the other wagons are, of course, drawn forward one stage for the next operation. The time taken to assemble the underframe complete in the jig is 30 minutes; therefore, all the operations required at the other stations have been divided so that 30 minutes is the time the wagon stands at each station.

Having got the wagon on to its wheels the second operation is to tighten up certain of the bolts that it is not necessary to tighten on the main assembly jig when putting the end stanchions up; one man tightens them up all the way round. The top and the main members are painted with jointing paste, and the axle guard bridles are put on. The wagon then goes forward to the third station. At this station—Op. No. 5—there are shoots coming down to the centre of the wagon from one side. In one shoot the draw-bar springs are carried, and in the other the draw-bar cradles. In the centre of the rails, and corresponding with the centre of the wagon, there is a platform for the men to stand on when using the big spanner for tightening up the draw-bar nuts inside the cradle. The draw-bars, which are naturally fairly heavy pieces, are kept at the correct height so that there is no need to lift them off the floor.

At the fourth stage—Op. No. 6—the curb rails, which have had the sill plates and door nosing pieces fixed on them, are pushed down the skidway, at the bottom of which they are approximately the right height for dropping into position on the wagon. The curb rails having been fixed, the side knees are placed in position.

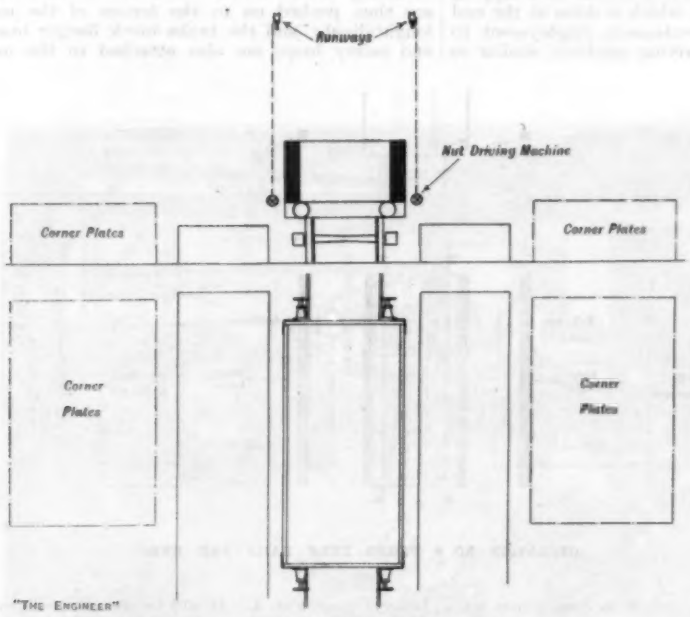
The wagon then goes forward to the fifth stage, and all the flooring, which can be seen at the side—see Op. No. 7—is fixed on the wagon. The flooring having been placed in position the end sheeting is erected and bolted up.

At the sixth stage—Op. No. 8—there are platforms on either side of the wagon, and on each of them there is a door jig comprising a trolley on rails on which there is fixed a frame. The door sheeting is dropped into the frame and bolted up; the frame is then brought round into a horizontal position and pushed forward, the cotters are knocked out of the hinges, and the door falls on to a roller conveyor. The wagon builder now goes round to the other side of the wagon, at which there is a similar jig fixed, and deals in a similar way with the other door.

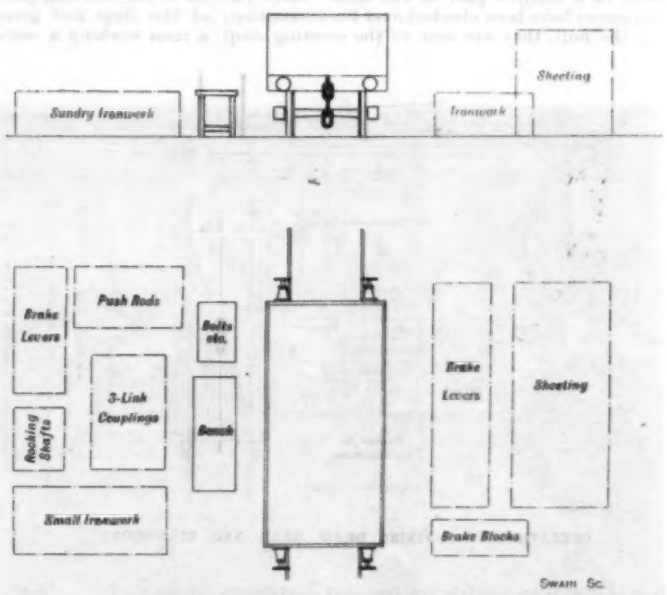
The wagon, going forward another stage, is stopped in the correct position for the door to be easily pushed down the conveyor, and fixed in place, and the side quarter sheeting is placed in position.

At the eighth stage—see Fig. 8 and Op. No. 9—the corner plates are fixed. The corner plate bolt nuts are tightened up by means of pneumatic double-geared drills which are used as nut drivers, and are hung on runways and balanced so that fatigue to the man is reduced to a minimum.

At the last stage—Op. No. 10—the brakes on either side are fixed, the doors are tried, and the wagon is generally examined by the examiner to see that it is in fit condition. This man, at the end of the assembly line, controls the moving forward of the wagons, which is done by means of a traverser outside the shop. This traverser is equipped with hauling gear, and on a whistle signal from the examiner at the door, it is brought into position and takes one wagon out, thereby drawing all the other wagons forward a stage, and leaving the first station vacant for starting operations again. The wagon just drawn out is then sent to the paint shop and is ready for service. It has already been explained that all the wagons are coupled together and by this means all of them are drawn forward one stage.



OPERATION NO. 9—FIXING CORNER PLATES, ETC.



OPERATION NO. 10—FIXING BRAKEWORK AND COUPLINGS

the end diagonals and longitudinals, the joints are squeezed up tight. The longitudinal knee is then dropped into position, and the diagonals bolted up to the diagonal knee. When this work has been completed, the headstock is pushed across on its conveyor into its position on the main jig, and is then squeezed home on to the tenons of the sole bar, diagonals and longitudinals by means of six rams at the ends of the jig.

The frame is now practically built; the axle guards are squared, and the frame is then lifted and placed on packing blocks; the buffer rods are slipped off the conveyors into position, together with the buffing springs. The wagon is then dropped back on to the table of the jig, and the four corner rams are used to compress the buffing springs, thus allowing the cotter and rebound rubber to be fixed without the need of any special appliances. This simultaneous compression of the buffers is one of the points which shows a great saving in time over the old method, as under normal circumstances a man would take one hour to put sufficient compression on the buffing springs to enable the cotter to be got into its place.

It will be noticed that up to this stage the wagon has been the wrong way up, and it must now be lifted off the jig and turned over. In order to do this a pair of trunnions is put through the hole in the headstock for the draw-bars, and the wagon is lifted by means of the crane and turned over. Fig. 6 shows the wagon in the act of being swung round whilst carried by the crane.

The wagon is now dropped on to the floor of the shop, and is picked up again at the four corners, by means of sling chains fixed to the framework of the crane, so that it may be lowered—see Fig. 7—on to the wheels, which are run underneath—Operation No. 4. Having got the wagon underframe on to its wheels, it is now in a position to be moved forward to the

Exhaust Valve and Cylinder Head Temperatures in High-speed Petrol Engines.*

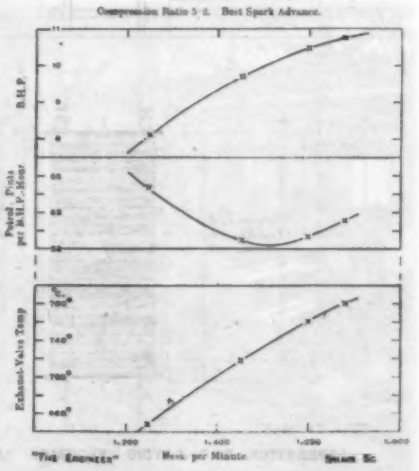
By Professor A. H. GIBSON and H. W. BAKER, M.Sc.

(*Continued from page 676.*)

Speed of Rotation of Engine.—Experiments on the standard cylinder have been carried out at full throttle and at speeds ranging from 1500 to 1800 revolutions per minute with the results shown in Fig. 10 *ante*. These refer to a compression ratio of 4.77. Experiments show that, so long as the spark advance is adjusted to give maximum power in each case, the effect of speed on valve temperature is sensibly independent of the compression ratio. Fig. 13 shows the results of tests on the modified cylinder at speeds from 1200 to 1700 revolutions per minute. These indicate a very appreciable increase in valve temperature with speed. The temperature rise per brake horse-power of increased output due to this cause is approximately 45 deg. The cylinder head temperatures also rise with increasing speed, but at a much slower rate, the total increase in the standard cylinder between speeds of 1500 and 1800 revolutions per minute being only 18 deg. Cent.

Spark Advance.—The timing of the ignition has a very pronounced effect on the temperature of the exhaust valve, and generally on the performance of the cylinder. The tests were carried out with a timing ranging from 20 deg. early to 45 deg. early, and show that for all compression ratios the lowest valve temperatures, the highest powers and the minimum petrol consumptions were obtained with the spark as fully advanced as is possible without causing detonation. This best advance depends on the speed and

FIG. 13—*Speed Tests—Standard A.S. Cylinder*
Compression Ratio 5·2. Best Spark Advance.



compression ratio, but in the cylinder in question the whole available range could be used at all compressions up to 5.07 at 1800 revolutions per minute. At 1200 revolutions per minute the best advance ranged from 45 deg. with a compression ratio of 4.0, to 30 deg. with a compression

* The Institution of Mechanical Engineers.—Abstract.

of 5.07. From these it appears that at all speeds from 1500 to 1800 revolutions per minute the valve temperature is reduced by about 40 deg. Cent. as the spark advance is increased from 20 deg. to 45 deg. At the same time, the cylinder head temperature is increased by 5 deg. at 1500 revolutions per minute and by 7 deg. at 1800 revolutions per minute. As the compression ratio is increased, at a given speed, the effect of a variation in the timing diminishes slightly. Experiments at half throttle show that the effect of a retarded spark in reducing the power is relatively even more marked than at full throttle, while the effect on the valve temperature is sensibly the same. So long as the spark advance is not so great as to produce detonation, it has very little effect on wall temperatures. Once continuous detonation is set up, however, the temperature shows a very appreciable rise. The timing of the ignition has such a marked effect on the exhaust valve temperature because it largely governs the type of combustion. It should be emphasised that, from every point of view, it is advantageous to work with as great a spark advance as is feasible without causing detonation.

Spark Plug Position and Inclination.—The effect on exhaust valve temperatures of the position, relatively to the valve, of the sparking plug has been referred to in connection with the tests on the air-cooled 5½in. by 6in. cylinder. In the A.S. cylinders two plug positions were provided at opposite ends of a diameter. As this diametrical plane is perpendicular to that containing the valve centres, these positions are symmetrical with respect to the exhaust valve, so that the effect of a change of plug positions should be negligible. One of these plugs was, however, horizontal, while the other was inclined at an angle of 35 deg. to the axis of the cylinder, and the effect of this inclination has been investigated.

The results show that the effect of the inclination of the plug on the power and consumption is very appreciable, especially with a spark not fully advanced. Whether with petrol or petrol-benzol mixtures the horizontal plug always gives higher power on a lower petrol consumption, and with exhaust valve temperatures usually slightly lower and in no case higher.

Influence of Jacket Water Temperature.—From tests on the Armstrong-Siddeley cylinders it was found that (*a*) there was a comparatively small effect on the cylinder head temperature from an increase in the jacket water temperature. (*b*) That the difference in temperature between the cylinder head and the cooling water at its outlet from the cylinder diminishes as the temperature increases, but if the mean head temperature C.H. be taken as the criterion, is still 94 deg. Cent. at the highest water temperatures. These cylinder head temperatures are no lower than are obtained in normal operation with a well-designed air-cooled cylinder of the same size. (*c*) That the great reduction in valve temperature, accompanying a reduction in cooling water temperature, is only to a small extent due to the direct cooling effect of the valve seat. The results would appear to indicate that the phenomenon of combustion is sensitive to comparatively small changes of temperature in the cylinder walls. Some indication of this had already been obtained by one of the authors in tests of air-cooled cylinders. No ready explanation of the phenomenon offers itself, and it is hoped to investigate this point in further research on the engine.

Type of Fuel.—In the majority of the tests Pratt No. 1 petrol was used as the fuel, but a number of runs were made on a mixture of 80 per cent. Pratt No. 1 and 20 per cent. benzol. Except at the highest compression ratios, at which detonation occurred with petrol and not with the benzol mixture, the effect on the performance of the engine was very slight. With a compression ratio of 4.26, at 1670 revolutions per minute, petrol gives about 1½ per cent. more power than the benzol mixture with a fully retarded spark and about 3 per cent. less power with a fully advanced spark. The exhaust valve is about 5 deg. cooler with petrol than with the benzol mixture with a fully retarded spark and about 5 deg. hotter with a fully advanced spark. With a 5.2 ratio the maximum power obtainable with the benzol mixture was 3.5 per cent. greater than with petrol, and the maximum exhaust valve temperature was sensibly the same as with petrol.

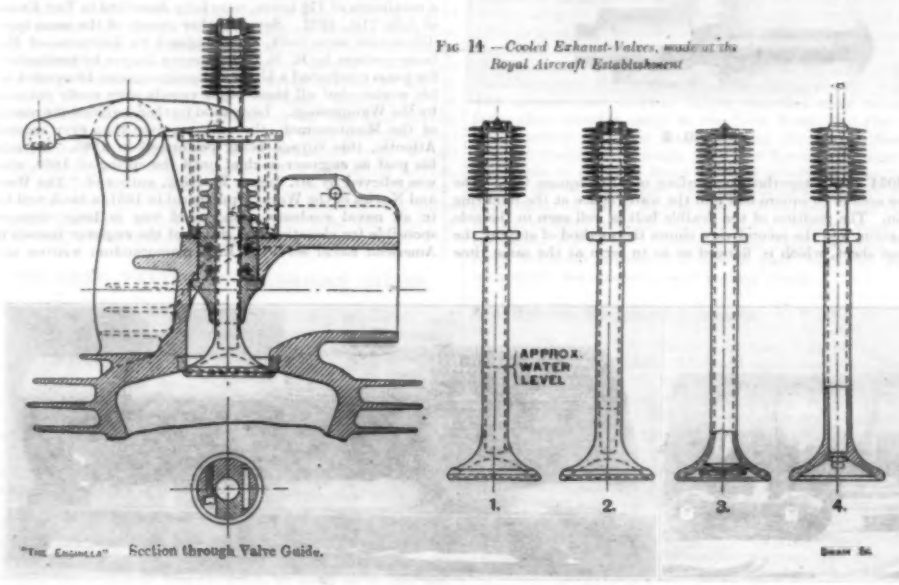
Water-cooled Exhaust Valves.—It is evident that the presence of an exhaust valve head at a temperature between 700 deg. and 800 deg. Cent., as part of the combustion space of a cylinder cannot but be detrimental to the successful operation of the cylinder. It forms a hot spot of considerable area which reduces the volumetric efficiency, and, by facilitating detonation and pre-ignition reduces the compression ratio at which satisfactory operation is possible, and thereby reduces the possible thermal efficiency. As the cooling effect of the valve seat and guide is inversely proportional to the diameter, the difficulty of cooling will be more serious as the size of exhaust valve is increased.

In order to determine the effect of cooling the valve, a series of cooled exhaust valves were made at the Royal Aircraft Establishment, and were tested by one of the authors. These were of the types shown in Fig. 14. In Nos. 1–3 the valve stem is hollow, and at its upper end, which is exposed to an air blast, carries a series of cooling fins, turned out of the solid. In No. 3 the valve head was bored out as shown, and a steel plug was afterwards welded in position to complete the head. The upper end of the stem is provided with a screwed plug, which is also welded in position, and is tapped for a small screw. The valve stem is filled to one-third its capacity with water, and the valve is placed in an oil bath at about 120 deg. Cent. until the water boils freely. The screw is then inserted and immediately welded in position, so that the whole is perfectly steam tight. In operation the heating of the valve head evaporates some of the water, which condenses on the cooled upper surface of the valve stem and trickles down its interior to be re-evaporated, and in this way, with a suitable adjustment of the area of cooling surfaces and of the valve head, the maximum temperature of the latter may be kept down to about 300 deg. Cent., or even lower.

When carefully welded, types (1) and (2) proved perfectly satisfactory in operation. Type (3) was unsatisfactory, owing to the difficulties of making a welded joint in the head of the valve which would stand up to the internal pressure and the inertia forces and vibration. In type (4) an aluminium alloy rod with cooling fins at its upper end was fitted tightly into the hollow stem and was riveted over at the underside of the head. This type proved useless, as, after a very short time, the rod became slack and its lower end burnt away.

Such valves were used with a split valve guide, of the type shown in Fig. 14, and a forked rocker arm. They have the disadvantage that their weight is greater than that of the normal valve.

FIG. 14.—*Cooled Exhaust-Valves, made at the Royal Aircraft Establishment*



Valves 1 and 2, which were 42 mm. in diameter, weigh 3.5 oz., as compared with 4 oz. for the normal uncooled valve, while the weight of the valve springs, rocker lever and guide complete is 26.5 oz., as compared with 14.5 oz. for the corresponding parts in a normal cylinder. These valves have twelve steel fins, 1.1in. outside diameter, providing a cooling area of 21.5 square inches, including the extra length of stem.

Tests on Water-cooled Valves.—The valves were tested on a unit having a single aluminium air-cooled cylinder, 100 mm. bore by 140 mm. stroke—Fig. 1, *ante*—under compression ratios varying from 4.7 to 6.2. The temperature of the head at a point 0.6in. from the seat—approximately the hottest point of a normal valve—was measured under various conditions. To obtain these temperatures the engine was run with open exhaust until all conditions were steady. The pin in the exhaust rocker lever was then pulled out, and a brake applied to the fly-wheel, pulling the engine up dead. A Pt. Ir. thermo-couple was then inserted into a ¼ mm. hole drilled into the valve head, and the temperature was recorded at intervals of 5 sec. A cooling curve was obtained in this way, which, when produced backwards through the axis of zero time, was assumed to give the temperature at the instant of stopping. The temperatures so obtained range from 250 deg. to 320 deg. Cent., and while not exact are probably correct within about 15 deg. Cent. The higher temperatures were obtained with a 5.5 compression ratio and the lower with a 4.7 ratio. The same cylinder was afterwards tested with an uncooled valve. Similar tests were also carried out on an aluminium air-cooled cylinder, 5½in. diameter by 6½in. stroke, with a single exhaust valve, 2.3in. diameter—Fig. 3 *ante*.

The results of typical tests are shown in the Table in the next column.

In the first series the temperature of the upper end of the valve stem was approximately 70 deg. Cent. lower than that of the head. Temperature measurements on the cylinder head and piston showed that under maximum load conditions, with a 5.5 compression ratio, the mean temperature of the cylinder head was reduced by 26 deg. Cent. by the external cooling of the exhaust valve; that the temperature difference between the exhaust and inlet side of the combustion space, and hence the tendency to distortion was appreciably reduced; and that the hottest point of the piston was 25 deg. cooler with the cooled valve in operation.

Cylinder.	Revs.	Comp. ratio.	B.M.E.P.	Petrol, lb. per B.H.P.-hour.	Temp. of valve.	Rem'rks
					°C.	
	1800	4.7	126.0*	0.535	260	Water-cooled valve
	1800	4.7	121.0	0.498	270	
100×140 mm. single aluminium cylinder (Fig. 1). Exhaust valve 42 mm. diam. in port.	1800	4.7	121.0*	0.538	700	Uncool'd valve
	1800	5.5	133.5*	0.534	300	Water-cooled valve
	1800	5.5	130.0	0.480	310	
	1800	5.5	127.5*	0.559	750	Uncool'd valve
	1800	5.5	123.5	0.511	770	
5½in. × 6½in. single aluminium cylinder. Exhaust valve 2.3in. diam. in port (Fig. 3).	1650	5.0	117.0*	0.545	400	Water-cooled valve
	1650	5.0	116.0	0.470	—	
	1650	5.0	113.0	0.448	—	
	1650	5.0	113.4*	0.561	760	Uncool'd valve
	1650	5.0	111.0	0.489	790	

* Maximum load conditions.

The results of a large number of tests show that as a net result of the cooling an average increase of 2½ per cent. in the maximum power is obtained, while the maximum power obtainable with an uncooled valve can be developed with a cooled valve, on a petrol consumption about 8 per cent. less than with the uncooled valve.

The cooled valve is relatively more advantageous at the higher compression ratios. It notably reduces the tendency to detonation and enables a higher compression ratio to be utilised.

While the experiments show that water-cooled valves of this type are capable of giving excellent results, care must be taken in the design, to ensure that the cooling surface on the valve stem is adequate. The critical temperature of water is approximately 374 deg. Cent., and if, owing to inadequate cooling, the temperature of the water attains this value, the whole of it will be turned into steam. Under these conditions, assuming the valve stem to be originally one-third full of water, the volume of the steam would be three times that of the water from which it was formed, and its density would be 20.8 lb. per cubic foot, corresponding to a pressure of approximately 4.5 tons per square inch. In one of the tests on the large valve the speed of the cooling air was reduced until this action did occur, with the result that a bubble was blown on the lower portion of the valve stem. From a knowledge of the diameter and thickness of the stem, and of the tensile strength of the material, it was calculated that the internal pressure must have been of the order of 4 tons per square inch.

In general, it may be taken that with a cooling wind of 60 miles per hour and with steel fins of the dimensions and pitch shown in Fig. 14, the cooling area of the fins for high-duty air-cooled aero-engines should be at least ten times the area of the valve head. For other wind speeds, the cooling area should be inversely proportional to $V^{0.72}$. This cooling allowance will keep the valve head at a temperature of approximately 300 deg. Cent.

In order to avoid the danger of exceeding the critical temperature of the cooling fluid, other fluids than water have been suggested. Aniline—B.P. 184 deg. Cent.—was tried, but was found to decompose after a short period of operation. Mercury—B.P. 358 deg. Cent.—was also tried. This, however, is extremely heavy, and since its cooling effect does not become marked until its boiling-point is reached, the valve is appreciably hotter than with water.

It is probable that some of the fusible salts might give fairly good results. The authors understand that a mixture of sodium and potassium nitrates—melting point 241 deg. Cent.—has recently been used successfully in the United States.

Conclusions.—The investigation goes to show that, in a well-designed and well-cooled overhead-valve petrol engine, either of the air-cooled or water-cooled type, under normal conditions of operation the temperature of the exhaust valve may be between 600 deg. and 750 deg. Cent. The temperature is effected by a large number of factors, the most important, in an engine operating without detonation, being the timing of the ignition, the temperature of the cooling water, and the strength of the working mixture. The highest temperatures under such conditions are attained at full throttle with the weakest mixture capable of maintaining maximum load, with the highest jacket water temperature, and with a retarded ignition.

In a given cylinder, with different compression ratios, the exhaust valve temperature at any given horse-power within the capacity of the cylinder having the lowest compression ratio, is sensibly independent of compression ratio.

If, owing to some such hot spot in a cylinder as may be produced by the action of a loose valve seat or of a defective sparking plug, pre-ignition is set up, the temperature of an exhaust valve may readily attain temperatures exceeding 800 deg. Cent. At such temperatures the valve, whether of chromium or tungsten steel, will rapidly burn out. At lower temperatures chromium steel has the advantage of not oxidising so rapidly as tungsten steel with weak mixtures, although at temperatures not exceeding 750 deg. Cent. both are capable of giving excellent results.

The best shape of valve head appears to be one having a flat bottom and a tulip-shaped top. Owing to the weight, this is in general impracticable, and the next best is one having a tulip-shaped head common in aero-engine practice. Increasing the lift of the valve within limits tends to cool operation by reducing the mean scouring velocity of the gases.

Within the limits usual in practice, tappet clearance does not greatly affect valve temperatures. Even negative clearance, so long as this does not exceed about 0.010in., has only a small effect.

Generally speaking, the conditions tending to give a hot valve also tend to give a hot cylinder head. The result of retarding the ignition is exceptional, in that it gives a hot valve but a cool head. The range in cylinder head temperatures corresponding to a given change in operating conditions is, however, much smaller than the range of temperatures of the exhaust valve.

Valve temperatures are sensibly the same whether petrol or a petrol-benzol mixture is used as a fuel. In this connection, benzol is only of real advantage under conditions in which the use of petrol would be accompanied by serious detonation, leading to pre-ignition.

By water cooling exhaust valves, the temperature can be reduced to about 300 deg. Cent., and such valves enable the output and efficiency of an engine to be appreciably increased. They also enable a higher compression ratio to be used. They are, however, only suitable for use on an air-cooled engine, and if water is used as the cooling fluid, unless carefully designed, are likely to prove a source of danger.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH BEET SUGAR MACHINERY.

SIR,—The paragraph entitled "The Kidderminster Sugar Factory," in your issue of December 14th, does not do justice to the sugar machinery manufacturers of this country.

To those familiar with the initiation of the Cantley and Kelham beet factories, it is well known that the former was promoted by a number of Dutchmen who had at their disposition a considerable quantity of used beet sugar machinery, and it was part of their policy that it should be offered to the proposed company and installed at Cantley. This was accomplished, and that machinery has been supplemented from time to time by German machinery. With regard to Kelham factory, the promoters placed themselves unreservedly in the hands of a French firm for the supply of machinery and the arrangement of the factory.

British machinery manufacturers were never invited to tender for the supply of machinery to Cantley, or Kelham, or Kidderminster. Had they been allowed to do so, a thoroughly sound scheme would have been put forward which would have shown that the sugar machinery manufacturers of this country can produce a plant which is at least equal to that produced on the Continent.

THE BRITISH EMPIRE SUGAR MACHINERY MANUFACTURERS' ASSOCIATION,
M. H. AIKENSON, Secretary.
45, Scotland-street, Glasgow,
December 22nd.

FIRE-BOX STAYS.

SIR,—The leading article in THE ENGINEER of the 14th inst. deals with a subject which is of considerable importance, and in reference to the remarks made relative to practice in the United States, I send you some illustrations of a type of flexible stay bolt much used on the United States railways and manufactured by the Flannery Bolt Company, Pittsburg, Pa., which, when I was in America, kindly sent them to me. The illustrations are self-explanatory. Fig. 1 is the standard type of water space stay; Fig. 2 is the pattern used for supporting the crown sheet; and Fig. 3 shows the method of applying the water space stays; while Fig. 6 illustrates a boiler having a complete installation of "Tate" stays as supplied by the Flannery Company.

I may say that it is not usual to use exclusively flexible stays as shown; they are generally used in what is termed the "breaking zone." The two illustrations Figs. 4 and 5 show the boilers used on the Pennsylvania for the splendid large K.4.S. 4-6-2 type express engines, having a total evaporative heating surface of 4034 and a superheating surface of 1154 square feet. The grate area is 70 square feet and the water space at the mud ring is 5in. The position of the flexible bolt is well seen in the side elevation, and the second view shows the method of staying the throat sheet, which is flanged so as to form at the same time the under part of the rear barrel section. These excellent photographs were courteously supplied by Mr. J. T. Wallis, Chief of Motive Power. The flexible stay bolts used by the Pennsylvania, while differing in detail from those made by the Flannery Company, act on the same general principle.

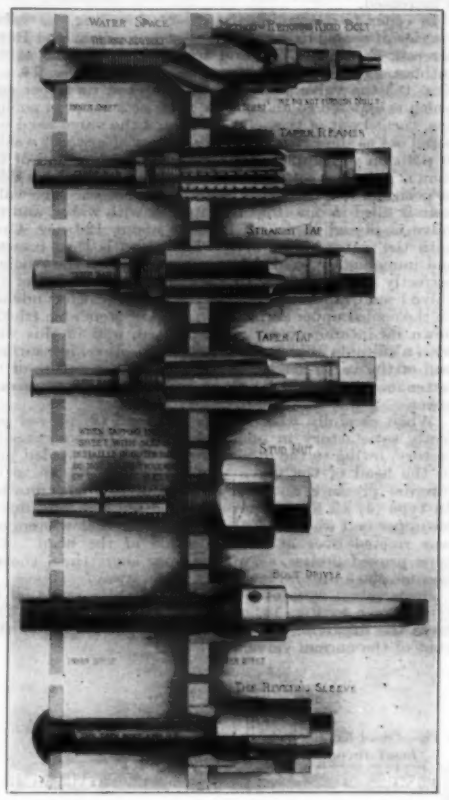


FIG. 3

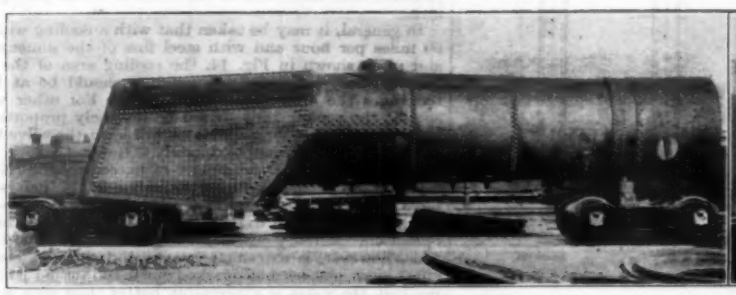


FIG. 4

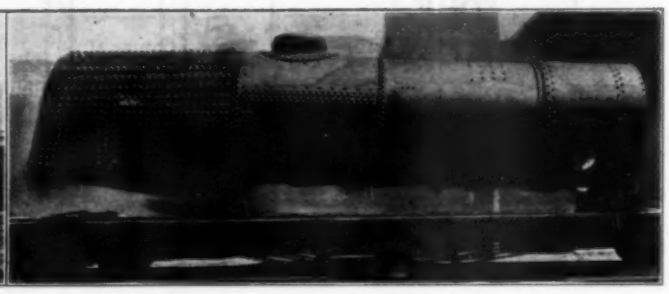


FIG. 5

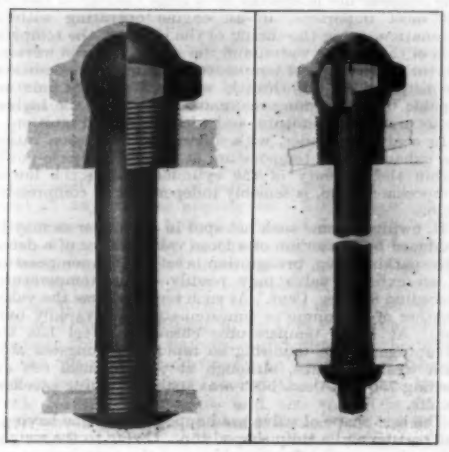


FIG. 1

FIG. 2

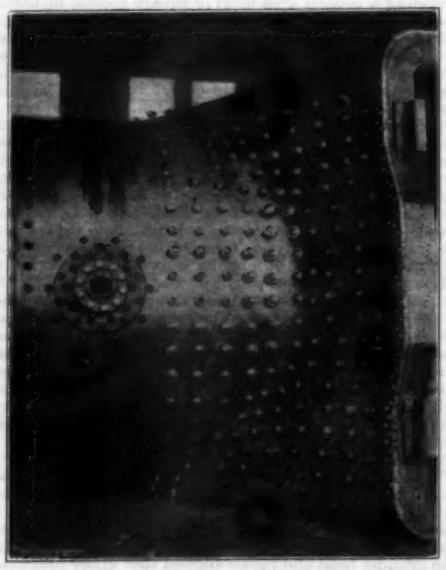


FIG. 6

The chief characteristics of stay bolt iron as used in American practice are as follows, the particulars given being taken from "The Locomotive Dictionary and Cyclopædia, 1919."

Tensile, lb. per square inch	47,000 to 52,000
Yield point, minimum, lb. per square inch	0.6 tensile
Elongation in 8in., minimum	30 per cent.
Reduction of area, minimum	48 per cent.

Bend tests are also required and the chemical compositions specified are phosporom, not over 0.150 per cent.; and manganese, not over 0.10 per cent.

E. CECIL POULTNEY.
Llandudno, December 17th.

ISHERWOOD AND THE AMERICAN NAVY.

SIR,—In your paragraph under the caption of "Sixty Years Ago," in this week's issue, you quote from THE ENGINEER of December 18th, 1863, some criticisms of Mr. Isherwood, the Engineer-in-Chief of the United States Navy, who seems to have held singular views on the expansion of steam, and to these you add the following comment:—"The futility of his investigations was apparently the subject of comment and inquiry, for we find it stated that, when under cross-examination, he candidly admitted that before he received his commission as steam engineer in the United States Navy he had never had charge of an engine." As these remarks seem to imply that Mr. Isherwood was an uninstructed amateur in the realm of steam engineering, may I be permitted to present the following facts about his career? Benjamin F. Isherwood was granted a commission in the engineering branch of the United States Navy in, I think, 1850. Previous to this he had been engaged in civil engineering work on the Erie Canal. On March 26th, 1861, he was appointed Engineer-in-Chief of the United States Navy. Mr. F. M. Bennett, in his "Steam Navy of the United States," notes that Isherwood was appointed over the heads of four seniors because "he was recognised as the foremost man of his corps in professional ability and zeal." That this appointment was justified is indicated by the fact that the engines of at least one hundred of the most successful vessels of the Federal Navy, built during the Civil War, were designed by him—those of the Monitor being the only notable exception.

In 1863 Isherwood designed the machinery of the fast frigate Wampanoag, whose remarkable speed trials, culminating in a maximum of 17¾ knots, were fully described in THE ENGINEER of July 21st, 1922. Several other vessels of the same type and dimensions were built, some engined by Ericsson—of Monitor fame—others by E. N. Dickerson—a lawyer by profession, who for years conducted a bitter campaign against Isherwood and all his works—but all these other vessels were easily out-steamed by the Wampanoag. Isherwood further designed the machinery of the Miantonomoh, the only monitor that ever crossed the Atlantic, this voyage being performed in 1866. He retained his post as engineer-in-chief until the spring of 1869, when he was relieved by Mr. James W. King, author of "The Warships and Navies of the World," published in 1881, a book well known to all naval students. Isherwood was in large measure responsible for elevating the status of the engineer branch in the American naval service. In a memorandum written in 1863 he said:—"The most important branch of study at the Naval Academy is, very appropriately, seamanship. A general knowledge of the application and use of steam and of practical mechanics should follow as almost equally essential. Line officers of the navy, of whatever rank, should, moreover, have the privilege of attending lectures and pursuing the study of steam and mechanics, and it is recommended that arrangements be made for carrying into effect these suggestions." Those were the days, be it remembered, when the school of "sticks and string" reigned supreme, and the engineer was looked upon in every navy as a necessary nuisance and treated accordingly.

In 1881 Isherwood was appointed a member of the Advisory Board constituted to report upon the types of vessels best adapted to American requirements. The labours of this board eventually bore fruit in the steel cruisers built a few years later, which formed the nucleus of the modern United States Navy.

I think it will be agreed, in view of the foregoing notes, that Mr. B. F. Isherwood was something more than an ignorant amateur in marine engineering, however unfortunate and mistaken his views on the use of steam expansively may have been.

HECTOR C. BYWATER.
23, Whitmore-road, Beckenham, Kent,
December 22nd.

THE annual exhibition of the Physical and Optical Societies, which is to be held on Wednesday and Thursday, January 2nd and 3rd, 1924, at the Imperial College of Science and Technology, Exhibition-road, South Kensington, will be open in the afternoon from 3 to 6 p.m., and in the evening from 7 to 10 p.m. Mr. H. B. Grylls will give a lecture on the Heape and Grylls rapid cinema machine, which is designed to take photographs at rates varying from 500 to 5000 per second, and Sir Richard Paget, Bart., will give a lecture on "The Nature and Artificial Production of Human Speech." Over fifty firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged.

American Engineering News.

AMERICAN "GALVANNEALED" WIRE.

A COMBINED galvanising and annealing treatment for wire, woven wire fencing and similar products, which are known as "galvannealed," has been introduced by the Keystone Steel and Wire Company, of Peoria, in order to increase the efficiency of ordinary galvanising. When a heavy coating of zinc is applied by the ordinary process, it is liable to crack, peel and flake off when the wire is bent, as in weaving or tying. The wire is thus made open to attack by rust and corrosion from moisture, salt air or spray, smoke, gas and acid fumes. With the new process, the zinc coating becomes integral with the steel, so that it will not be detached, even by severe treatment. In addition, the coating is left at its original thickness instead of being reduced by the asbestos "wipers" used to press the zinc on the wire. In galvannealing, the wires with their heavy coating of zinc pass from the bath of molten zinc into a heat-treating furnace, so that the coating remains soft for a sufficient time to ensure even distribution and a smooth surface free from pin-holes. With the high temperature of this heat treatment, there is an amalgamation of the surface of the steel wire with the zinc, so that the latter will not separate during fabrication processes. The galvannealed wire stands a much higher chemical test than ordinary galvanised material.

LOADING MACHINES IN COAL MINES.

THE use of machinery is an important factor in securing more efficient production of coal, according to the engineering report of the American Coal Commission. The day of the mechanical loader is said to be just dawning. Nearly half the men in coal mines are employed to shovel the coal by hand from the room floor to the pit car. The use of the machines will mean fewer men required, but it will also mean higher wages and cheaper coal. The increase to the overhead cost in interest, depreciation and maintenance will be offset many times over by reduction in total labour costs and other costs of production. A number of machines of this class were exhibited at the recent convention of the American Mining Congress. They were of three general types, all portable, and nearly all mounted on caterpillars instead of wheels. One type has a large bucket operated by a lever system to dig up the coal, swing it sideways or overhead, and dump the contents into a mine car behind or at the side of the machine. The latest machine of this type was described recently in THE ENGINEER. In the second type, a belt or pan conveyor is supplemented by a gathering device, which sweeps the coal into the receiving end of the conveyor. In the third type the conveyor consists of a series of small buckets, which gather up the coal and carry it to the rear, where it is discharged into a mine car.

CONCRETE PAVING IN AMERICAN CITIES.

THE use of concrete as a street paving material, and not simply as a base for some surface material, is increasing steadily in the United States. A recent case is at Seattle, where the old surfacing on a busy street in the business section had become worn out. It was decided to use concrete, and in order to adapt it to the tramway tracks a total thickness of 7in. was placed on the original 6in. concrete base. A 1 : 2 : 3½ mixture was used, with gravel for the coarse aggregate. Tramway traffic was diverted temporarily, and two machines travelling on the rails mixed and placed the concrete paving of the tracks. Two other machines, travelling on the old concrete base, placed the concrete for the roadways between the tramway line and the sidewalks. Expansion joints were placed at intervals of 20ft. As the work was done in hot summer weather, the concrete was covered, as soon as it had set, with burlap, which was kept damp. For the ten-day period of curing, the concrete was kept wet by means of automatic sprinklers. In some cities the tramway companies pave their lines with concrete, whatever material may be used for the sides of the street. In most cases, the concrete is reinforced with steel wire netting, and expansion joints are then often omitted.

AMERICAN SHIPBUILDING.

IN the autumn of 1923 there were 198 steel vessels, of 164,236 gross tons, and 8 wooden vessels of 1004 tons, under construction, or under contract, at thirty-two American shipyards. This is exclusive of vessels for the United States Navy, or other Government Departments. The Shipping Board has sold 7 steamers of the "President" type to the Dollar Steamship Line for a "round-the-world" service, which is to be operated for five years. From San Francisco—the home port—the ships will go by way of Japan, China, the Philippine Islands, Java, the Straits Settlements, Singapore, India, the Suez Canal, Egypt and Mediterranean ports, thence across the Atlantic to New York, and through the Panama Canal to the Pacific Ocean and San Francisco. Each boat is of 10,550 gross tons register. The Shipping Board now has on hand 1330 vessels, but only 416 of these are in operation or ready for service, as follows:—365 cargo boats, 30 passenger boats, 19 tankers, and 2 refrigerator boats.

BRIDGE PIERS BUILT TO STAND HURRICANES.

IN the rebuilding of its bridge across the Little Rigolets Pass, on the Gulf Coast, near New Orleans, U.S.A., the Louisville and Nashville Railroad had to consider the severe storms and heavy wave action due to hurricanes on the Gulf of Mexico. The plan adopted is to build hollow cylindrical piers, 34ft. in diameter for about 40ft., and then 29ft. in diameter to the top. The interior well is 16ft. diameter, and the lower portion is filled with concrete after the pier has reached its full depth. A double-shell cylindrical caisson will be sunk by open dredging for each pier, but provision is made for capping to permit of using the pneumatic process if necessary. The depth of water is 45ft. to 55ft., and the caissons will be sunk through mud, clay and sand to depths of 80ft. to 115ft. below sea level in order to avoid danger of scour by the heavy current through the pass. The first section of each caisson will be floated into a partial cofferdam of steel sheet piling, the cofferdam being then completed, and the caisson built up as it sinks with the concrete load. No reliance is placed upon the caisson for permanent strength, but the concrete shell will be heavily reinforced. The bridge will have eight through truss spans of 330ft., and a swing span of 420ft., this last being carried on a solid circular pier 34ft. in diameter.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Christmas Holidays.

THE iron trade generally in the Midlands and Staffordshire has been taking a full week's holiday for Christmas, but several of the steel works, having very good order books, restarted to-day—Thursday. The closing meeting of the year was unproductive of business, many buyers and sellers being still on holiday, and those attending on 'Change being desirous of postponing financial commitments until the New Year. Industrialists are giving attention to stocktaking and the overhauling of their resources preparatory to the trade which is hoped for in the New Year. Undoubtedly, the trade will benefit very much from the substantial rolling stock orders lately placed, Staffordshire mill owners expecting to be called upon to supply large quantities of iron and steel for rolling stock construction. Iron and steel business has undoubtedly closed the year on a firmer note than has been sounded during some earlier months. In the heavy industries of the Midlands there will be a considerable carry over of orders. The forward movement of the past month or two, with its accompaniment of rising prices, has caused consumers of metals to look farther ahead; nevertheless, they are still cautious in their anticipation of future requirements. Stocks are light in almost every branch of manufacture. Compared with the stocks which were carried in pre-war days, they are very light. The prospects of renewed competition from Germany now that the Ruhr is again becoming active has inspired a spirit of precaution in the handling of prices of iron and steel. Developments on the Continent are being closely watched. The expectation is that larger supplies may be offered from that quarter early in the New Year. In the meantime, prices seem to be hardening for some classes of Belgian materials, though very low figures are mentioned for semis as distinct from finished products. As regards native prices these are well maintained, despite certain exceptions of some significance. Iron and steel masters in this district, on the whole, take a cheerful view of the prospects for 1924. Optimism has been assisted by the large business placed within the past week by railway companies for material and rolling stock.

New Railway Equipment Contracts.

Much satisfaction is expressed here at the manner in which the London, Midland and Scottish Railway Company has divided up its new great equipment contracts, and this district is getting its full share of the business. The Midland railway carriage and wagon firms welcome the orders which have this week been received, and which include 500 12-ton wooden-frame mineral wagons, to be made by the Metropolitan Carriage, Waggon and Finance Company, of Saltley, Birmingham, and 250 similar vehicles, to be produced by the Midland Railway Carriage and Waggon Company, of Washwood Heath, Birmingham. The first-named firm is also to supply 500 12-ton steel-framed merchandise wagons and the second firm 250. Other contracts booked in the district are as follows:—Shelton Iron and Steel Company, Stoke-on-Trent, 6000 tons of steel rails; Kerr, Stuart and Co., Stoke-on-Trent, 50 goods locomotive boilers and 250 12-ton wooden-frame mineral wagons; and Gloucester Railway Carriage and Waggon Company, 225 12-ton wooden-frame mineral wagons. Following closely upon the announcement of the placing of these contracts comes the details of a further large programme of locomotive and rolling stock construction by the London and North-Eastern Company, and there will be keen competition among the local firms to secure a full share of the contracts. The Staffordshire mills hope to supply good tonnages of iron and steel for the new wagons.

Manufactured Iron.

The improvement in the Staffordshire manufactured iron trade is more than maintained, and most of the works will be considerably busier when they resume operations on Monday. It is a good augury for this district that not only is wrought iron coming into more active demand in the United Kingdom, but exports are likewise expanding. The tonnage of bars, rods, angles, shapes and sections shipped last month amounted to 4534, as compared with 3997 in the previous month. Makers of best bars in Staffordshire have a fair amount of work on their books, and find no difficulty in securing £14 10s. for marked iron. Crown bars sell at £12 10s., and nut and bolt bars at about £11. Nut and bolt iron requirements are increasing, and local makers are taking a large proportion of the business, even in face of offers of Belgian material at £8 15s. delivered in the district. Iron strip remains on the basis of £12 10s. to £12 15s. Wrought iron scrap is difficult to obtain, even at £5 to £5 5s. Galvanised sheets are quieter and an increasing number of firms are quoting below the £19 basis. Some want £18 17s. 6d., but others are willing to accept £18 15s. It is interesting to note that the shipments of galvanised sheets last month once more exceeded 60,000 tons. A renewal of export buying is anticipated on the opening of the New Year.

Raw Iron Position.

Pig iron business is sufficient to absorb the comparatively small output, and the furnaces are in a favourable position for the New Year in this respect. The requirements of various railways have relieved any anxiety which was occasioned by the pig iron stocks a month or two ago. Pig iron business has expanded sufficiently during the past month to bring ten additional blast-furnaces into operation. But none of these are in the Midland district. Coke is the pivot on which the industry turns. The shortage of this material is becoming aggravated, and prices several shillings above the agreed figure of 24s. per ton at ovens are being asked. This development will discourage smelters from rekindling idle furnaces. There is increased demand for both foundry and forge pig iron, and prices are very firm on the basis of recent quotations. The scarcity and dearness of wrought iron scrap has created a bigger demand for pig iron for the Staffordshire iron trades.

Steel Prices Easing.

Semi-finished steel values are easing. The heavy tonnage of billets ordered lately has more than covered prospective requirements, offers of new business being few and far between. Makers seeking business have been obliged to shade prices, £8 10s. now being the general figure, as compared with £8 15s. a week ago. Sheet bars are at about the same level. The fall in prices has been hastened by keener foreign competition, a matter to which I gave prominence in my letter a fortnight ago. Belgian billets are now obtainable at £7 5s. to £7 7s. 6d. delivered in the district, and fairly heavy sales have been made at this level. Finished steel values remain firm, but here foreign competition is not quite so keen, only small quantities being on offer. The makers of steel plates so far linked up in the Association are holding together in regard to prices, and there is little deviation from the £10 10s. standard for ship, bridge and tank plates, and £14 for boiler plates. There is no great confidence as to the maintenance of the standard figure when competition becomes keener. Small steel bars continue to be quoted £10 15s. to £11, and an increased number of makers are joining the Small Bar Association. For gas tube-making steel strip can be bought at £10 15s. per ton. Belgian finished steel is not much in evidence, but joists are on offer at £6 18s. 6d. f.o.b., equal to £8 3s. 6d. delivered here. Such competition is rather formidable against the native price of £10.

Scrap Values Declining.

Steel scrap values are now falling, a repressing element in the market being the arrival of large quantities of continental material. Last week I intimated that lower prices might be expected. For urgent needs a fortnight ago £5 per ton was being paid, while last week the minimum stood at £4 15s. This week good quantities have been offered at £4 10s., while one large works is said to be offering at £4 7s. 6d. delivered. Consumers are now holding off with a view to testing the market next month.

Miners' Wage Agreement.

On previous occasions Cannock Chase miners have indicated their desire that the existing wage agreement should continue, and it is expected that in the forthcoming ballot that attitude will be maintained. No action has yet been taken locally.

Unemployment.

There has been a welcome improvement in the unemployment position in the Midlands during the past two months, the number of persons out of work having decreased steadily until they now stand at 144,944. The weekly falls during November and December have been 3854, 2081, 2305, 2918, 2918, 1108, 4528, or a total for the seven weeks of 19,712. It is hoped this improvement will be maintained in the year about to be commenced.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel and Metals.

THE last week of the year in Manchester is practically all holidays. Theoretically, the offices were open on Monday, but no business of any importance has been done since Friday, December 21st, and the character of the markets has remained unchanged. It is not expected that any further change for the better will be seen next week, as in Lancashire a good deal more is made of the New Year holiday than in the South of England, but it is hoped here that towards the end of the next week business for the New Year will begin to show itself. It is noticeable that besides the two extra furnaces for hematite which were started a fortnight ago, two more furnaces for foundry iron have been blown-in for the making of Cleveland iron.

Metals.

The year closes with copper in a rather depressed condition, and the improvement which was seen for a time in the earlier part of the month is again slowly fading away. Copper opened the year with standard at £64 12s. 6d. per ton, electrolytic ingot at £71 15s., and best selected at £68, and although we have not, as we wish, the closing prices, they will be about £62, £67 15s. and £66 respectively. All through the year there have been expectations, continually revived, of a return to higher prices in the copper market, but on each occasion disappointment has occurred after each upward movement had proceeded a little way. The year is closing with copper as dull a market as it has ever been; but for all that the prospects for the New Year are probably much better than they were a year ago. The vast expenditure proposed by the British railway groups ought to have some beneficial effect on the metal markets in this country. Manufactured copper and brass have altered very little during the year. The January prices for sheets were £96 per ton; for tubes, 1s. 1½d.; for locomotive brass tubes, 11½d.; and for condenser tubes, 1s. 2½d.; and the December

prices are, for sheets, £95; for copper tubes, 1s. 1½d.; for locomotive brass tubes, 1s.; and for condenser tubes, 1s. 2½d. Tin has moved much more during the year, the lowest prices, round about £180 per ton, occurring during the early months, and the highest prices, up to £237, during the closing months. The general statistical position of tin is thought to have improved during the year, it being probably the fact that month by month the consumption has been above the actual monthly output. Some progress has, therefore, been made in reducing the reserve stock, and optimists in the market are foretelling an advance to £250 per ton. Lead has improved by about £4 per ton during the year, but, on the other hand, spelter has declined by about the same amount. English pig lead is now at about the same price as g.o.b. spelter, a very unusual situation in the metal trade.

Iron and Steel.

There is, of course, no change in the markets here for iron and steel since I last wrote, simply because people have not been doing anything; but the feeling is very strong, and some optimistic anticipations are being indulged in for next year. It seems quite probable that a further advance in prices is coming in the early part of the year; but it would be rash to assume that this will continue very long. Possibly, the price for steel will advance until it becomes reasonably profitable to produce; but it must not be forgotten that the productive capacity of the country is employed only to about 60 per cent. of its power, and this applies to crude iron as well as to manufactured iron and steel. A steady increase in the production may probably be looked for during 1924, and this should keep all prices from running away, at any rate in an upward direction. Pig iron is rather dearer now than it was at the opening of 1923; but it is not nearly so high in price as it was soon after the French had stopped the industries in the German Black Country. At the present moment there is certainly a good prospect of an increased demand from home consumers, but the whole productive capacity of British iron furnaces cannot be absorbed by the home trade, even if that is prosperous. We shall have to recover more of the export trade if all the furnaces are to be employed.

Scrap.

The scrap trade has been dull and relatively bad throughout the year, and for a long time almost every kind of iron and steel scrap has had to be sold at much less than its value as compared with the new material. As the year closes, however, the feeling in the scrap iron and steel trade is rapidly improving, although the same cannot be said about the scrap metal trade. Here prices are still enormously below the intrinsic value—in the case of gun-metal by about £25 per ton. Steel scrap is now scarce, and there is little doubt but that a good demand for it at over £5 per ton will be seen early in January. For heavy wrought scrap the ironworks in Lancashire are paying 95s. per ton, and dealers expect a rise to £5. Cast scrap is simply waiting until the iron-founders get to work next year. There are rumours that in the Lancashire district many more orders for castings have been received, and this should bring about a demand for good cast scrap.

BARROW-IN-FURNESS, Thursday.

Hematite.

The tone of the hematite pig iron market is healthier, and a steady improvement in demand is noticeable. A feeling of confidence prevails, and it will not be long before there is an increase in the number of furnaces in blast, for the steel works are taking a considerable amount of iron, and this, combined with better trade, is causing all iron smelted to be sold. With the increased activity in the shipbuilding and engineering trades, there is sure to be a bigger demand for ordinary mixed Bessemer numbers, and also special qualities. The continental business is only moderate, but here, again, there are signs of improvement. Scotland should prove a bigger customer in the early future, in view of the improved outlook.

Iron Ore.

The iron ore trade is only moderately engaged, and this condition will obtain until more furnaces are put in blast. A certain, but not large, quantity is going out of the district to Scotland and Yorkshire. The business being done in Spanish and other foreign ores is not great, and will remain in a sluggish condition until the iron trade improves.

Steel.

The steel trade is better, and more orders have been booked. The Workington rail mill has a certain amount of work, but the orders held will not keep it going quite regularly. The Barrow rail mills are working, and this week secured an order from the London, Midland and Scottish Railway for 10,000 tons. Steel prospects are better than they were. Foundries have a better outlook, and the hoop and small section mills are fairly well circumstanced.

Shipbuilding and Engineering.

As hinted at last week, some relatively good orders have been received at Barrow. There are two steamers for the London, Midland and Scottish Railway Company for the Goole-Continental service, and another steamer for the Canadian Lakes. Further than this, Vickers have the overhauling of the Cæsarea, which the Isle of Man Steam Packet Company has purchased from the Southern Railway Company, and which is to be altered for the Douglas service. Vickers also announce that they have received an order from the Cunard Company to convert the Coronia from coal burning to oil burning. This is rather a big job. The Coronia will arrive in Barrow early in January. The Cæsarea is already at Barrow. Barrow shipbuilding and engineering prospects are much brighter, and there is still chance of further work in the early future.

SHEFFIELD.

(From our own Correspondent.)

General Trade Outlook.

CONTRARY to the anticipations of a few months ago that Sheffield would have to pass through a fourth winter of serious unemployment, the conditions at the close of the year are distinctly bright, and on all sides there is a feeling of confidence. This in itself will go a long way towards encouraging trade, and business men in the city can point to several important factors which tend to show that the steel trade has turned the corner. A complete return to normal is not anticipated, but such headway has been made that the trade lost in the summer has been regained, and various iron and steel departments are attracting business which will cause a substantial expansion of trade throughout the East End of the city early in the New Year.

Heavy Steel Trades.

The improvement has been most marked on the heavy side. Outputs of both basic and acid steel are considerable, though not yet up to full capacity in Sheffield. Lincolnshire finishes the year with great activity prevailing, as for some time past. This has been largely due to the boom in the South Wales tin-plate trade, which absorbs a considerable proportion of the output. The modernised No. 3 furnace at the Alfreton works of the Stanton Ironworks Company, Limited, has been relighted. It has a capacity of 350 to 400 tons per week. More employment will not be caused immediately, but it is understood that No. 2 furnace is being "blown out" for re-lighting, and more men will be required when that is completed. The management state that these works have not been in so flourishing a condition for many years. The new pipe plant is turning out more tonnage, and is breaking all records.

Trade with Russia.

Discussions that have arisen recently with regard to this country reopening trade relations with Russia have been followed with great interest in Sheffield. A few orders from that country are already to hand, and many more would doubtless be forthcoming if some satisfactory arrangement could be arrived at in respect of payment or credit. Russia is very anxious to get deliveries of the steel products of Sheffield, but manufacturers naturally will not accept contracts without a reasonable guarantee of payment.

Special Steel Prospects.

Among the things that Russia needs is special steels of the kind for which Sheffield is famous all the world over. Only a small proportion of the furnaces are working, but an improvement is recorded, and orders for small quantities are coming through steadily. The price of the best tool steel is very high for continental countries where the currency has been inflated, yet it cannot be said that the price is prohibitive, for trade is still being done even with Germany. Users abroad realise the high quality of this steel, and this recommendation alone brings orders to Sheffield. Some valuable business has been placed by the United States. There is only a quiet demand for engineers' small tools, but here, again, an upward movement is noticeable. Makers of saws are experiencing a very busy time, and the works are pretty well up to their full capacity. Considerable activity prevails in the manufacture of farm and garden tools, the season for which has opened briskly in view of the shortage of stocks.

Railway Contracts.

Details have already been published of Sheffield's share in the railway contracts, and the list now appears to be complete. The city has had no intimation of participation in some of the big orders to be placed by the London and North-Eastern Company, but if a direct share of the work does not come a number of the large firms will benefit indirectly. Sheffield district has long felt the need of railway orders in another direction. One of the greatest handicaps to the great coal export industry of South Yorkshire, Derbyshire and Lincolnshire during the past year has been the shortage of wagons for transport between that area and the Humber. This has resulted in serious delay and great inconvenience to merchants and shippers.

Bad Year for Cutlery and Plate.

Generally, cutlery and plate manufacturers have experienced an unprofitable year. There has been a fair volume of business, but competition has been so keen that quotations have barely covered the cost of production. Seasonal orders are now at an end, and so far as the best quality articles are concerned little business is being transacted. Forks and spoons of the cheaper grades are selling well. Retailers, who bought cautiously for the Christmas season, report that more cutlery and plate were sold than had been anticipated.

Retirement of Professor Ripper.

The close of the season at Sheffield University has seen the retirement of Professor W. Ripper, who for many years occupied the Chair of Mechanical Engineering and was the head of the Applied Science Department. He commenced his educational career as organiser of technical classes at a Sheffield school. In the interest of engineering development in Sheffield it is gratifying to know that Dr. Ripper's help will still be available in the new post of Adviser in Technology.

Chinese Industrial Mission.

Early in the New Year Sheffield will be visited by an Industrial Mission from China, the members of which are interested in many sections of engineering, shipping, coal mining and transport. When in the steel city they will visit the works of Messrs. Vickers, Hadfields, Edgar Allen and Co., A. Balfour and Co., the Hardy Patent Pick Company, and Walker and Hall's. This tour will give them a fairly comprehensive idea of the industrial activities of Sheffield.

Hull Water Scheme.

Hull Corporation will commence work in January on a £50,000 scheme for laying a new water main in parts of the city. It is estimated that the work will take about five months to complete. Tenders are to be asked for the supply of between £30,000 and £40,000 worth of cast iron pipes.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THERE is every prospect of a much better trade position in the North of England in the near future. Works are gradually extending their operations to execute orders in the New Year for pig iron, shipbuilding requisites and railway material. Among the big contracts just announced is an order from the London, Midland and Scottish Railway for 8000 tons of steel rails to be delivered by the Cargo Fleet Iron and Steel Company, and there are confident hopes that other bigger demands will follow. It is reported that a contract for 73,000 tons of pipe castings is about to be placed with northern firms. The restarting of blast-furnaces continues, two more having been blown-in during the past week. Of 114 on the North-East Coast, 48 are now in operation, compared with just over 70 in normal times.

Cleveland Iron Trade.

A strong undertone characterises the Cleveland pig iron market. Business has, of course, been interrupted by the Christmas holidays, but during recent weeks transactions have been on an unusually heavy scale, and producers have excellent order books. Prospects, on the whole, are regarded as quite encouraging, notwithstanding the weaker tendency of continental markets and reports that German works may be competing again before long. Indeed, the prevailing opinion is that values of pig iron in this district are more likely to advance than otherwise after the holidays. The supply is none too plentiful, and the undertone of firmness and confidence in the future is emphasised by the fact that home consumers have been buying well ahead at rather above current rates, and some of the contracts extend over the whole of next year. The demand is almost entirely for home consumption, export business being on quite a trifling scale. Prices are all steady, No. 1 being 106s. 6d., No. 3 G.M.B. 100s., No. 4 foundry 97s. 6d., and No. 4 forge 96s. 6d.

Hematite Pig Iron.

A brisk condition of affairs prevails in the East Coast hematite pig iron trade. The steady expansion in production has not thrown any surplus on the market, and following the resumption of work last week at the Thornaby Ironworks of Whitwell and Co., Limited, Pease and Partners are putting into operation two furnaces at their Normanby works, which will increase the number of furnaces running on hematite to seventeen. Mixed numbers are steady at 102s. 6d., and No. 1 at 103s. 6d.

Ironmaking Materials.

Business has shown a little more activity in the foreign ore trade, and a few contracts have been placed for supplies over the first quarter of next year. Sellers firmly adhere to 25s. per ton c.i.f. as their price for best Bilbao rubio ore. There is a fairly good supply of coke, and good medium furnace kinds are variously quoted at 37s. to 38s. per ton delivered at the works.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trade has shown a marked improvement in recent weeks. Further big rail orders have been placed, and the works are, for the most part, comfortably placed. Prices are firmly maintained.

The Coal Trade.

The Northern coal trade has assumed a somewhat quiet and erratic condition. There is not much in the way of new business about. Most of the small amount of trade passing this week has consisted of oddments for completion purposes; the buyers in almost every case prefer to await the turn of the year before venturing to commit themselves ahead. The export section of the trade is very quiet and formal, with nothing much moving, though there is said to be some tangible prospect of heavier buying on account of the German importers for January and February shipment, but at present this is all in prospect, which may, or may not, be realised. The home trade is fairly heavy and serves to clear the bulk of the output in the case of Durham, so that the prospects are that there will be no change from the present satisfactory position for some time yet. The tone of the Northumberland steam coal section has improved considerably, though the recent stormy weather on the coast has played havoc with the tonnage arrangements, and has caused a good deal of coal to be thrown on the market. In such circumstances it is possible to discount prices. The position of second screened steams is rather better than that of the first grades. The collieries are said to be fairly heavily stemmed for January, so that relatively high prices can be obtained for any supplies available. The Durham market continues to be very firm in every instance. The coking coal position is exceedingly strong. The demand shows absolutely no sign of slackening away as yet, and as supplies at present are far from adequate to overtake the demand, prices are very strong and are still tending upward. The bunker market is also firmer in tone and prices are strong. Gas coals are steady and in

good demand. The coke market is weak with foundry classes in full supply, but with a very poor demand. Gas coke is nominally steady and unchanged in price.

SCOTLAND.

(From our own Correspondent.)

Home Conditions Improving.

THE home situation continues to improve. The past week has brought promise of further activities in various directions. More railway contracts have been mentioned, including most up-to-date passenger vehicles, mineral wagons and locomotives. A considerable portion of this work will, of course, be executed in the railway workshops, but private enterprise will also benefit. The steel and iron works, too, will benefit from these orders. More work of a similar nature is in prospect. Some time must elapse, however, before the necessary materials are to hand and employment augmented at the constructing shops. The prospect of work is encouraging, nevertheless. The shipyards, too, are becoming busier and have a brighter outlook. One or two fresh orders have been placed, and important repair work is mentioned. Inquiries, too, are more prolific. Apart from putting things in order very little can be done until after the holidays. In a very few weeks, however, arrangements should be well advanced and the state of employment considerably improved. One can hardly omit the remark that everything is subservient to the preservation of industrial peace, and it is, therefore, fervently hoped that the present murmurings of unrest may be suppressed immediately and trade given a fair chance to revive.

Pig Iron.

So far as regards the home market a very steady attitude is maintained in the pig iron trade. The week has been quieter so far as actual business is concerned, due, no doubt, to the proximity of the New Year holidays, but consumers still show an inclination to cover requirements. Hematite and foundry qualities are comparatively well booked, but in view of the state of output and the rising market makers are not too anxious to enter into extensive forward contracts. Prices are maintained at last week's levels. The export department is quiet at present, but an increased demand here would probably only mean higher prices all round.

Steel.

Apart from increased quotations there has been little change in the steel trade for some weeks back. The works are a little more active, but specifications in connection with shipbuilding and other contracts recently placed have not yet come forward to any extent, and the output in plates and sections is still below capacity. Time, however, will bring increased production. There is still no falling off in the demand for sheets of both light and heavy description for home delivery. Galvanised varieties, too, are well bought for export. The rising costs of raw materials foreshadow a further stiffening in the prices of all steel products.

Buxier Ironworks.

In anticipation of the recent advance in iron many consumers contracted as far forward as possible, and the works are now fairly busy. Despite the advance inquiries are fairly well maintained and specifications fairly plentiful. The same remarks apply to the position with regard to re-rolled steel.

Coal: Scarcity of Supplies.

The scarcity of coal for prompt delivery is pronounced, and business is difficult to negotiate. The collieries in all districts are fully booked for export, and the production is already ear-marked. Consequently, there is really nothing available, apart from second-hand lots offered by holders anxious to clear before the holidays. Owing also to heavy commitments, the collieries are not anxious to entertain fresh business, while buyers, on the other hand, are content to purchase as little as possible, in view of the high prices ruling at present. Washed nuts are almost as firmly held as round coal. The home demand improves. General utility requirements are, of course, at their height at present, and house coal is very busy, in spite of high charges. The call for industrial fuel improves, but buying is kept within strict limits, in view of the effect of prices on oncosts.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Steam Coals in 1923.

EXPECTATIONS that the steam coal trade would show an improvement during the past year upon the conditions of 1922 have been realised. The figures for this month are not, of course, available, but it is a fair estimate that the output for South Wales will be about 54,500,000 tons for the year. This compares with 50,562,600 tons for 1922, so that it will be seen that there has been a material advance, though the total falls short by about 2,200,000 tons of the output for the record year of 1913, when the total was 56,830,072 tons. A feature has been the additional employment found for men at the mines, for whereas the average number of workmen engaged in 1922 was 220,728, it is estimated that the average number for the past year is 240,000. The wages of the miners have been a source of discontent practically throughout the whole twelve months, with the result that it has been decided to ballot the workmen on the question of giving three months' notice to terminate the national agreement. Throughout the first six months of 1923 the wage rate in the South Wales coalfield was on the minimum, viz., 28 per cent. above the 1915 standard. For July and August the wage rate was 37.62 per cent.; for September and October, 41.47 per cent.; and for November and December, 28.66 per cent.; while for the first two months of 1923 the rate is back upon the minimum. During the past year values of steam coals displayed considerable fluctuation. The occupation of the Ruhr by the French was responsible for a sharp demand from France, Italy, Germany and Belgium for coals from this country during the first few months of the year, and best Admiralty large advanced from 28s. 6d. per ton to between 43s. 6d. to 45s. in April and May, but from that time onward the continental demand fell off somewhat sharply, and the downward trend of prices was assisted by the heavier outputs of coal from this district, until in October best Admiralty large commanded only 27s. 6d. However, the last two months of the year saw a revival in the shipments abroad, with the consequence that best large coals recovered to 30s. It may be added that best small coals reached as high as 33s. 6d. during the year, while their lowest price on the market was 17s. per ton.

Miners' Wages.

The secretary of the South Wales Coalowners' Association has officially announced that the certificate of the joint accountants for the months of September and October shows that after allowing for the standard wages, other costs and the owners' standard profits, the general wage rate percentage payable in the coalfield in January and February next will be 28 per cent. on the 1915 standard rates, as compared with 28.66 per cent. in November and December. After allowing for standard wages, other costs and standard profits, there is available a surplus of £959,933. This is distributable in the proportion of 83 per cent. to the workmen and 17 per cent. to the owners, and it is only enough to justify a general wage rate of 26.93 per cent. on the 1915 standard rates, and therefore the owners will have to pay the miners their minimum wage of 28 per cent. on the 1915 standard rates, and to do this they will have to sacrifice £42,000 of their share of the proceeds, to which they are entitled under the agreement. In addition to this 28 per cent., however, the lower-paid workmen receive a subsistence wage in accordance with Earl Buxton's awards.

Weighing of Coal at Docks.

A very important subject was raised at a meeting of the Cardiff Chamber of Commerce last week, when the chairman, Mr. C. L. Clay, introduced a discussion on dock facilities. The question of importance was that of weighing and screening of coals at the docks. Apparently, the suggestion had been put forward on behalf of the Great Western Railway Company that this operation should be done away with at the docks, and that the system adopted in the North of England should be introduced, viz., that the coal should be weighed at the pits. The chairman pointed out that this would cause difficulties, and alter the whole arrangements in the South Wales coal trade. Screening might be dispensed with, but the weighing of the coal at the pits was a different proposition. It was stated by a representative of one of the colliery companies that the Commercial Committee of the Coalowners' Association had already considered the matter, and had decided to make representations to the Great Western Railway Company as to the impracticability of the proposal. Eventually, the Chamber passed a resolution strongly protesting against the proposal to do away with the weighing of coal at the docks. There seems to be little doubt that all concerned in the coal export trade are against the Great Western Railway Company's idea. Complaints from abroad are not infrequently rather numerous, and exporters would stand very much less chance of successfully resisting claims for short weight if the Great Western Railway's proposal came into operation, as under the present system exporters are able to produce the dock company's certificate of the weights. Assuming that the weighing was done at the collieries, it could not be denied that there might be a good deal of pilferage of coal in the course of transport or while on sidings, and the claims against the collieries might in these circumstances be considerable; but with the weighing carried out at the docks immediately before shipment, short weight is reduced to a minimum, and claims from receivers of cargoes on this account can be resisted.

Loading of Coal Cargoes.

South Wales shipowners have recently been notified by the Board of Trade that a new rule has been introduced which will necessitate the loading of all vessels to the satisfaction of the Board of Trade. All steamers, whether self-trimmers or otherwise, are affected. Hitherto, the trimmers have been required to load vessels to the satisfaction of the master of the steamer, who has been held responsible for the stability of the ship, and there has been very little complaint; but it will be recollected that some time ago some French-built ships were lost at sea under conditions that induced the French Government to take action in the matter. At Swansea the Board of Trade prevented certain ships from sailing until the cargoes had been levelled in the holds, so as to do away with the risk of vessels being lost through coal being left in the form of a cone moving from one side of the vessel to the other. The French Government sent experts to travel with certain ships from the Welsh ports, and elaborate tests were made of the action of such vessels at sea. It appears that the withdrawal of certain steamers from service was due more to the design of the ship than the loading: but still the British Board of Trade has felt it necessary to take steps to safeguard the safety of ships and crews by ensuring that vessels shall leave dock in proper trim and with the cargo levelled so that in stormy weather the liability of the cargo moving shall be minimised. In dealing with cargoes of anthracite nuts, peas, &c., the rules are more drastic, involving the use of shifting boards where necessary, which, of course, especially affects Swansea, Llanelly and Port Talbot. It is possible that the new rules will involve claims from the trimmers for the extra work in levelling off all cargoes, which operation will not take more than a quarter or half an hour in the case of each steamer. The Cardiff and Bristol Channel Shipowners' Association met on Monday to consider the Board of Trade communication respecting the loading of certain types of steamers, and it was decided that the Board of Trade should be asked to receive a deputation of shipowners and consider proposals which in its opinion would be more effective than the present suggested regulations.

Current Business.

Business on the coal market has practically been at a standstill during the past week owing to the holidays. Most exporters made arrangements last week for the loading of steamers due to arrive immediately before or after the vacation. The loading pressure at the docks has been exceedingly heavy, but while there have been complaints of the slowness of work on some ships, it cannot be denied that on the whole the shipment of coal has been very good. Whereas at the beginning of last week there were over ninety steamers waiting at the various docks for berths, before the end of the week this number was reduced by half. Many steamers have had to wait until after the holidays for their cargoes, and there is every prospect that there will be good tonnage supplies available for the first fortnight of January. The demand for coal from abroad is, however, very quiet, though the Egyptian and Sudan Government are inquiring for prices for 200,000 tons of Welsh steam large coals for delivery in monthly quantities, commencing from March. Tenders have to be received at Cairo on February 5th. The Belgian State Railways are also in the market for about 30,000 tons of small coals for delivery over three months. The tone of the market generally is very steady, but in view of the holidays prices are purely nominal.

CATALOGUES.

PETER BROTHERHOOD, Limited, Peterborough.—A copy of the new steam turbines catalogue.

BEDFORD ENGINEERING COMPANY, Bedford.—Catalogue of "Bedford" steam and electric cranes.

ATELIERS J. HANREZ, SOCIETE ANONYME, Monceau-sur-Sambre, Belgium:—Three-language catalogue on locomotives.

BRUSH ELECTRICAL ENGINEERING COMPANY, Limited, Falcon Works, Loughborough.—Catalogue No. 500 on induction motors.

BARNES, BRAND AND CO., 3, Victoria-street, S.W. 1.—A catalogue of new Government surplus pumps, machinery and other stores.

ANDREW BARCLAY, SONS AND CO., Limited, Caledonia Works, Kilmarnock, Scotland.—Catalogue of light class locomotives (spare parts list).

FOSTER ENGINEERING COMPANY, Limited, Wimbledon, S.W. 19.—List No. L60, lanterns for gas-filled lamps; and leaflet on gas-filled lamp fittings.

J. H. HOLMES AND CO., Portland-road, Newcastle-on-Tyne.—Booklet on the Holmes-Clatworthy system of electric driving of newspaper printing presses.

CONSOLIDATED PNEUMATIC TOOL COMPANY, Limited, 170, Piccadilly, W. 1.—Special hammer drill circular No. 89 on the "Little Giant" B.Q46 hammer drill.

CAMPBELL AND ISHERWOOD, Limited, Raleigh-street Works, Bootle, Liverpool.—General catalogue on electrical machinery for marine and industrial installations.

WEST'S GAS IMPROVEMENT COMPANY, Limited, Albion Ironworks, Miles Platting, Manchester.—An illustrated description of Albion Ironworks and an account of the firm's activities.

J. J. ARMFIELD AND CO., Limited, Vale of Avon Works, Ringwood, Hants.—A handbook for the preparation of preliminary schemes of the development of water power, incorporating a catalogue of water turbines, &c.

ROBEY AND CO., Limited, Lincoln.—Copy of catalogue No. 382 on valves manufactured by the company under Rose's patents. List No. 386/1923 on Robey class "K" horizontal engine with automatic expansion gear.

NORRIS, HENTY AND GARDNERS, Limited, Barton Hall Engine Works, Patricroft, Lancs.—Catalogues on Gardner engines, C.R. vertical petrol-paraffin series, H.F. horizontal (cold starting) heavy oil type, T. vertical heavy oil type, and the Gardner patent multi-point lubricator for steam and internal combustion engines, air compressors, &c.

LAUNCHES AND TRIAL TRIPS.

ASCANIA, liner; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of the Cunard Steamship Company; dimensions, 536ft. 0in. by 65ft. 3in. by 43ft. Engines, twin-screw Parsons steam turbines, pressure 220 lb.; constructed by the builders; launch, December 20th.

THE SYMONS GOLD MEDAL.—The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1924 to Dr. Takematsu Okada, Director of the Central Meteorological Observatory, Tokyo, Japan. The medal is awarded for distinguished work in connection with meteorological science, and will be presented at the annual general meeting on January 16th, 1924.

UNIVERSITY COLLEGE, LONDON, ENGINEERING SOCIETY.—The Engineering Society of University College, London, has arranged to hold its annual dinner on Friday, February 1st, 1924. The dinner will be held in the College Refectory, and after it there will be a Conversazione in the Engineering Building, so as to afford members an opportunity of seeing the new Engineering Laboratories. Old students of the Faculty of Engineering who wish to be present are invited to communicate forthwith with the hon. secretary of the Engineering Society, University College, Gower-street, London, W.C. 1.

MOTOR BOATS FOR HONG KONG.—A detailed report on the market in Hong Kong for small power-driven craft and engines has been prepared in the Department of Overseas Trade from information received from the Commercial Secretary at Shanghai, Mr. H. J. Brett. This report is supplementary to the second of a series on this subject which has been issued to those firms whose names are entered on the "Special Register" of this Department. Other United Kingdom firms desirous of receiving the report and any subsequent reports from other markets are requested to make application to the Department of Overseas Trade for a form of admission to the "Special Register."

Current Prices for Metals and Fuels

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	25/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 8 9	—
No. 1 Foundry	5 11 3	—
No. 3 Foundry	5 6 3	—
N.E. Coast—		
Hematite Mixed Nos.	5 2 6	5 2 6
No. 1	5 3 6	5 3 6
Cleveland—		
No. 1	5 6 6	5 6 6
Silicious Iron	5 6 6	5 6 6
No. 3 G.M.B.	5 0 0	5 0 0
No. 4 Foundry	4 17 6	4 17 6
No. 4 Forge	4 16 6	4 16 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0	—
„ „ Foundry	4 15 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 13 6	—
„ Forge	4 7 6	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 16 6	—
Forge	4 9 0 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 0	—
(4) N.W. Coast—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 15 0 (a) / 6 0 0 (b)	— / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best „	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 0 0	—
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 10 0	—
Ship Plates, ½in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 5/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 0 0	—
Joists	10 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 5 0†	—
Light „	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
Manchester—		
Bars (Round)	10 10 0 to 10 15 0	
„ (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
„ (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 0 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
Midlands—		
Small Rolled Bars	10 15 0 to 11 0 0	
Billets and Sheet-bars	8 7 6 to 8 15 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	14 15 0 to 19 0 0	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	£34 5 0
„ (three months)	£36 5 0
Copper (cash)	£62 7 6
„ (three months)	£63 2 6
Spanish Lead (cash)	£31 5 0
„ (three months)	£31 7 6
Spelter (cash)	£32 11 3
„ (three months)	£32 16 3
Manchester—	
Copper, Best Selected Ingots	£68 10 0
„ Electrolytic	£68 0 0
„ Strong Sheets	£95 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	£33 0 0
„ Foreign	£31 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£22 0 0	8/-
„ 8 p.c. to 10 p.c. „	£21 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£65 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 8/- per unit	
„ Vanadium	20/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
„ „ Ell	25/-
„ „ Splint	25/6 to 28/6
„ „ Trebles	25/-
„ „ Doubles	23/6
„ „ Singles	21/6
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
„ „ Splint	25/6
„ „ Trebles	25/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	22/- to 23/9
Screened Navigation	28/-
Trebles	26/- to 27/-
Doubles	23/6
Singles	21/6
Lothians—	
(f.o.b. Leith)—Best Steam	24/-
Secondary Steam	23/-
Trebles	25/3
Doubles	23/6
Singles	21/6
England.	
(8) N.W. Coast—	
Steams	29/-
Household	48/- to 50/-
Coke	43/6
Northumberland—	
Best Steams	24/3 to 25/6
Second Steams	21/6 to 23/-
Steam Smalls	14/6 to 16/-
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 25/-
Second	23/- to 23/6
Household	25/- to 28/-
Foundry Coke	50/-
Sheffield	Inland.
Best Hand-picked Branch	33/- to 34/- —
Barnsley Best Silkstone	27/6 to 29/- —
Derbyshire Best Brights	27/- to 29/- —
„ „ House	23/- to 24/- —
„ „ Large Nuts	22/- to 23/6 —
„ „ Small „	17/6 to 19/6 —
Yorkshire Hards	22/- to 23/6 —
Derbyshire „	21/- to 22/6 —
Rough Slacks	13/6 to 15/6 —
Nutty „	10/- to 12/- —
Smalls	5/- to 8/- —
Blast-furnace Coke (Inland)	26/6 to 27/6
„ „ (Export)	f.o.b. 32/- to 33/
Cardiff—	(9) South Wales.
Steam Coals:	
Best Smokeless Large	29/6 to 30/-
Second „ „	28/6 to 29/6
Best Dry Large	27/6 to 28/-
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	28/6 to 29/-
Western Valley „	27/6 to 28/6
Best Eastern Valley Large	27/6 to 28/6
Ordinary „ „	26/- to 27/-
Best Steam Smalls	21/- to 22/-
Ordinary „	18/- to 21/-
Washed Nuts	30/- to 31/-
No. 3 Rhondda Large	28/- to 29/
„ „ Smalls	25/- to 26/-
No. 2 „ Large	25/- to 26/-
„ „ Through	20/- to 22/-
„ „ Smalls	19/- to 20/-
Coke (export)	55/- to 60/-
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	29/- to 29/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	34/- to 36/-
Red Vein	32/- to 33/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 57/6
Beans	42/6 to 45/-
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/-
Rubbly Culm	13/3 to 14/-
Steam Coals:	
Large	24/- to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Competition.

THE year just closing has been a particularly difficult one for the engineering trades, which have experienced great trouble through the irregular supplies of raw material and unsettled prices. The practical stoppage of consignments of coke from the Ruhr brought home to the French their absolute dependence upon foreign fuel for smelting their iron ores, and although the home production of coke has considerably increased, it is obvious that blast-furnace proprietors will always have to rely more or less upon the hard coke that can only be procured at a reasonable price from Germany. Now that affairs in the Ruhr appear to be settled, arrangements are being made to bring up the coke production to its normal level, and it is affirmed that, from January, the consignments to this country will be amply sufficient for all requirements. It is therefore assumed that in the coming year there will be a steady increase in the output of iron and steel, not only in France, but also in Germany, which will be able to profit from the freedom accorded to German producers so long as they carry out the terms of the agreement to continue supplies for reparation. With an expected decline in the cost of raw material, the prices of rolled iron and steel will come down, on condition that wages and charges do not correspondingly increase, and the French are looking forward to a period of competition that may change the aspect of the continental market. If industrial enterprise should be stimulated at the same time, with the aid of credits and a more active financial participation, the demand for iron and steel will be probably quite sufficient to absorb all the production without its being necessary to find outlets for any surplus; but, unfortunately, financial confidence is the last thing that is likely to be restored, and iron and steel firms may still have to seek new markets for their material.

Olympic Engineering.

The arrangements being made for the Olympic Games in the coming year include the carrying out of some considerable constructional works, such as the Stade at Colombes in the suburbs of Paris, where most of the Games will be held. The ratepayers have accepted the additional burdens involved by this huge expenditure with as much good grace as is possible, in view of the fact that they regard with some misgiving an invasion which may complicate the problem of living in an already overcrowded city. When, however, they are called upon to pay still heavier sums for the construction of a vast swimming bath in ferro-concrete, with arenas, under conditions where it is almost impossible to estimate the cost with any accuracy, the Parisians raise their voices in vigorous protest. The Municipal Council had voted a grant towards the Olympic expenses of 6,300,000f., but the cost of the swimming bath alone has already exceeded that sum, and the Council is now being asked to increase the credits to nearly 12 million francs. The City Councillors learn to their surprise that no preliminary sinkings were made to ascertain the nature of the ground upon which the huge arena was to be built, with the result that it is now found necessary to employ about 900 concrete piles for a foundation, and as the capacity of the baths is 25,000 cubic metres, there is naturally a good deal of speculation as to what use can be made of this expensive construction when the Olympic Games are over. As the work can hardly be stopped, or even curtailed, it is probable that the necessary funds will be provided, but the Councillors are seeking those on whom to fix the blame for having led them into assuming financial obligations out of all proportion to the interest of the work that has been put in hand.

Water Pollution.

The regulations concerning the discharge of sewage and waste are so lax that little has been done for the protection of rivers and waterways, and until a few years ago a very large quantity of Paris sewage continued to be diverted into the Seine. The laying out of sewage farms and bacterial beds, however, has accompanied a considerable progress in sanitation, which is profiting from every new advance being made abroad, and although there is still much to be done to reform the primitive methods that exist nearly everywhere outside some of the big towns, the Government, nevertheless, feels that the time has come to adopt drastic measures to prevent the pollution of the waterways. Now that systems of purification and filtration are within reach of municipalities and the manufacturing industries, it has been decided to introduce a Bill into the Chamber of Deputies providing that all waste discharged into the waterways must conform to certain bacterial conditions which are fully set forth in the Bill.

Regulating the Seine.

Among the schemes that have been suggested for maintaining the Seine at a fairly constant level is one that provides for the construction of vast reservoirs into which the surplus will flow during the season of high water and floods, and will be diverted into the river during the five months when the level is usually low. The author of this scheme is M. Henri Chabal, who proposes to construct twenty-three reservoirs having a total capacity of 2325 million cubic metres, and this volume of water would be returned to the Seine at the rate of 16 million cubic metres daily during the dry season. Hydro-electric plants would be installed at the reservoirs and the barrages, which latter would have a constant head of water, and the energy produced would amount to a very large figure. It would be possible to irrigate about 10,000 acres, and at the same time the scheme would provide a solution of the problem of providing Paris with all the water it needs. In view of these advantages, it is argued that the estimated cost of 1700 million francs for carrying out the entire scheme is fully justified, but the chance of its being adopted appears somewhat remote in view of the putting in hand of the less ambitious scheme for deepening the Seine to permit of the creation of a seaport in Paris.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

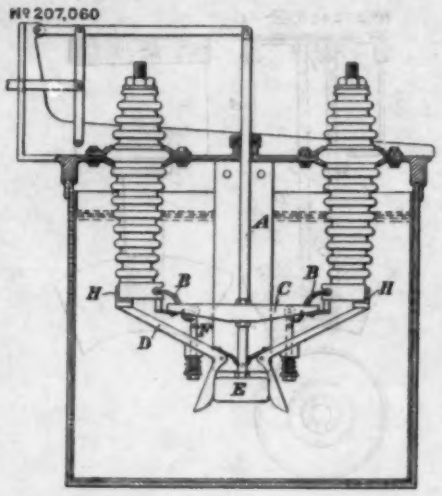
Copies of Specifications may be obtained at the Patent Office Sale Branch, 28, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

207,060. December 21st, 1922.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SWITCHES, *The British Thomson-Houston Company, Limited, of Crown House, Aldwych, London, W.C. 2.*

This invention relates to electric switches of the type having primary contacts which normally carry the current, or most of it, and secondary contacts at which, when the switch is opened, the circuit is finally broken. Automatic or manual tripping of the operating means causes downward movement of the

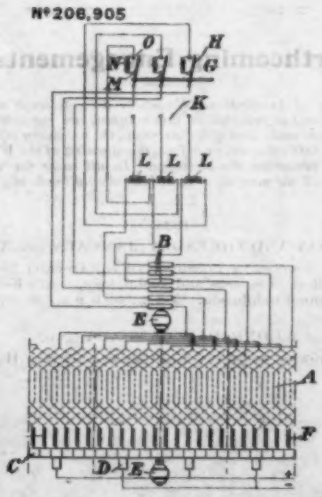


operating rod A, breaking contact between the primary brushes B and the primary bridging member C, the secondary contact members D being held in engagement with the secondary contact members H by the restraining block E until the restraining block has cleared the lower ends of the secondary contact members. Further movement of the operating rod A will cause the pins F in the accelerating member to engage with the secondary contact members D and cause their disengagement with the secondary contact clips H to make the final break in the circuit.—*November 22nd*, 1923.

ELECTRICAL APPLIANCES.

206,905. August 12th, 1922.—IMPROVEMENTS IN THE CONSTRUCTION OF ELECTRIC ROTARY CONVERTERS, The English Electric Company, Limited, of Queen's House, 28, Kingsway, London, W.C. 2, and Giulio Schroeder, of the same address.

This invention relates to rotary converters and applies particularly to the case where these machines are arranged to be started up as induction motors by applying alternating current at reduced voltage to the slip rings of the armature. It has been found that by combining bearings having a low frictional resistance to starting and running with resistance connectors inserted between the commutator segments and the coils of the armature

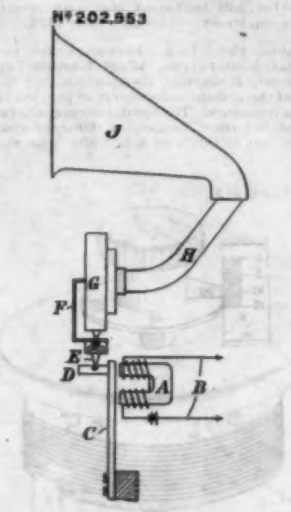


winding, it is possible to start rotary converters by the application of alternating current to the slip rings without producing objectionable sparking. The lap wound coils of the armature are indicated by A, the six slip rings by B, the commutator segments by C, the brushes on the commutator by D, the roller bearings by E, and the resistance connectors inserted between the commutator segments and the armature coils by F. These connectors are made of some high resistance material, such as an alloy of nickel and chromium, and each is bent back once on itself and suitably insulated in order to obtain a sufficiently high resistance between the armature coil and the commutator segment to which it is connected. The six slip rings B are connected as shown through the automatic throw-over switch G to the secondary windings of a three-phase transformer. When the arms H of the switch are switched into contact with the studs K the left-hand portions of the energised windings L are connected to the slip rings and the converter starts up on reduced voltage. After an interval of time, during which other automatic switches not shown make suitable connections to energise the field windings of the converter, the arms G are moved first into contact with the studs M, whereby the whole of the windings L are connected to the slip rings through resistances N, and, secondly, into contact with the studs O, whereby the resistances N are cut out of circuit, leaving the whole of the secondary windings L connected to the slip rings, thus applying full voltage to the converter.—*November 12th*, 1923.

TELEGRAPHS AND TELEPHONES.

202,953. March 2nd, 1923.—IMPROVEMENTS IN LOUD-SPEAKING TELEPHONES, Gesellschaft für Drahtlose Telegraphie m.b.H. of 9, Tempelhofer Ufer, and 12/13, Hallesches Ufer, Berlin.

According to this invention a loud-speaking telephone is formed of an ordinary gramophone sound box, the ordinary straight needle of which is vibrated at right angles to its length by the armature of an electro-magnet in the coils of which flow



the currents representing the sound to be reproduced. A is an electro-magnet, the coils of which are connected in a circuit B B, in which flow currents due to the speech. The armature C of the magnet carries a projection D, in which is seated the needle E connected by a lever F to the diaphragm of the ordinary gramophone sound box G connected through a tone arm H to a horn J. —*November 22nd*, 1923.

MACHINE SHOP AND TOOLS APPLIANCES.

207,440. February 19th, 1923.—TWIST DRILLS, R. Tyler, 55, Craven-street, Coventry, Warwickshire.

The object of this invention is to provide an improved form of cutting tool that is easily sharpened, and one that is not easily damaged permanently. The invention consists of a hollow cylinder or sleeve, which is provided with a cutting edge at one end of it. It is intended to be used in conjunction with a twist drill and the like. The cutting edge of the sleeve could take the form of serrations or teeth or a knife edge. The sleeve would have circular and longitudinal adjustment relative to the drill it is used in conjunction with, and also is capable of being clamped firmly to the drill in the desired cutting position. The method of clamping could be accomplished by splitting the sleeve at the opposite end of it to the cutting edge, and clamping it to the drill by screws. To put device into operation, the sleeve is passed over the drill, the cutting edge of sleeve relative to the cutting edge of drill decided on, and then the sleeve is firmly clamped in position. It is now ready for use. In order to facilitate the combination tool—that is, sleeve and drill—clearing itself from the cuttings during the cutting operation, portions of the sleeve are cut away.—*November 29th*, 1923.

MISCELLANEOUS.

198,662. May 10th, 1923.—IMPROVEMENTS IN AND RELATING TO VARIABLE ELECTRIC CONDENSERS, Dr. Georg Seibt, of Hauptstrasse, 9, Berlin-Schöneberg, Germany.

This invention relates to a variable condenser of the kind in which relatively movable metal coatings are separated from one another by a very thin dielectric, preferably mica, and in which one or both of the metal coatings are constituted by metal foil. A drum T of vulcanite is lined over half of its periphery with metal, for instance, by screwing on to it a portion of a brass tube R of suitable diameter which has been cut in the longitudinal direction. A small and very thin sheet of mica is silver-plated and copper-plated only on one side, and is placed with its non-coated side on to the drum, being lightly pressed against the drum by means of a thin band of bronze B. The bronze band is rigidly connected at one end A to a base or support, and its other end is connected to the base through the spring F, which allows the bronze band and the very thin sheet of mica lying underneath to press gently against the drum. In order to prevent a displacement of the sheet of mica relatively to the bronze band, the two are riveted together at one end. The layer of silver and copper-plating that is provided on the thin mica sheet before the assembling of the condenser serves as the one coating of the latter, the leading-in of the current being effected by means of the bronze band. The other coating

of the condenser is constituted by the semi-cylinder of brass which is secured on to the drum of vulcanite. It will be seen that when the drum is rotated, the size of the metal surfaces

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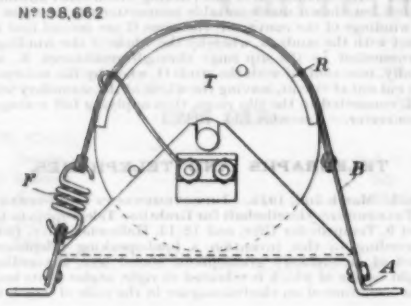

facing each other will be varied and consequently also the capacity of the condenser.—*November 15th*, 1923.

206,912. August 15th, 1922.—Improvements in Variable Electrical Resistances, Albert Edward Taylor, of 14, Harman-road, Erdington, Birmingham.

The object of the present invention is to provide an improved construction of resistance. The resistance comprises a cylindrical insulating block or former, a resistance element formed by winding simple (*i.e.*, not coiled) wire A helically upon the periphery

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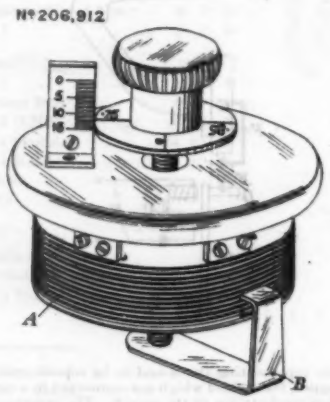

of the block, and a contact member or brush B having a contact face which extends for a short distance along the length of the resistance element and is shaped longitudinally to correspond with the curvature of the wire and shaped transversely to agree with the cross section of the resistance wire, the contact member being arranged so that it slides along the length of the resistance element.—*November 15th*, 1923.

207,439. February 16th, 1923.—Settling Apparatus, T. Tait, Broomend, Inverurie, Aberdeenshire.

This invention relates to apparatus for settling solids held in suspension in liquors. The outlet B of the vessel A is open to

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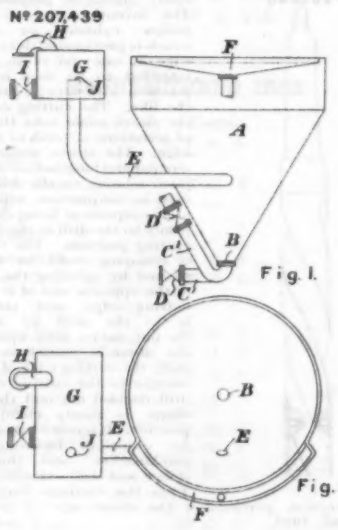


Fig. 1.

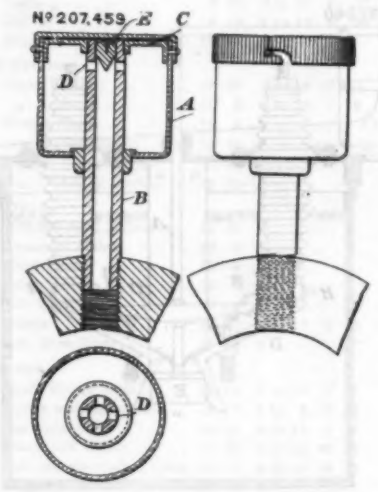
Fig. 2.

the pipe connection C, fitted with a wash-out valve D and the connection C¹ fitted with a control valve D¹ and connected to the mixing box of the machine. The supply pipe E is connected to the side of the vessel A, and is so dimensioned as to be capable of taking all the water to be treated. The pipe E is so disposed that the liquid is introduced into the vessel tangentially. At its upper end the vessel A is provided with a lip or overflow F by way of which waste water, freed of solid, is permitted to run away. In practice, there is provided a service box G to receive the entire backwater of the machine, such box G being of substantial depth and placed so that its upper edge is but slightly above the level of the lip F. To the upper end of the service box is connected a feed pipe H, through which flows into the vessel all the water to be treated. At the lower end of the service box G is an outlet valve I of sufficient size to feed all the backwater required to the machine. The service box has also an overflow J of sufficient height to maintain a full head on the valve I to prevent induction of air. The overflow discharges into the supply pipe E. On starting up, the outlet valve I of the service box G is opened and surplus water flows through the pipe E to the vessel A, which it enters tangentially so as to set up a vortex motion of the liquor within the latter. When the vessel A is sufficiently full to permit discharge through the pipe connection C¹ to the mixing box, the valve I is slightly closed and the control valve D¹ adjusted to pass what has been shut off from the valve I. As soon as the vessel A is filled, practically only clear water flows away over the lip F, while the water flowing through the pipe connection C¹ contains all the solids.—*November 29th*, 1923.

207,459. March 17th, 1923.—Centrifugal Lubricators, R. E. Goldsbrough and Goldsbrough Patents Company, Limited, 86, Pilgrim-street, Newcastle-on-Tyne.

This lubricator is intended for rotating parts, such as loose pulleys. The grease container A is free to slide on the stem B.

No 207,459



At the top of the stem, which is hollow, there is a piston C, and holes D below it communicate with the bore. A grub screw E can be used to control the opening of the holes D. The lubricator is filled in the position shown, and the centrifugal action of the cup itself forces the lubricant down the hollow stem to the part to be lubricated.—*November 29th*, 1923.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The White Machine Tool Company asks us to announce that it has changed its business premises from Warley Springs Works, Halifax, to Dunkirk Works, Parkinson-lane, Halifax.

Messrs. Newtons, of Taunton, announce that on and after January 1st, 1924, their sales department will be transferred from Victoria-road, Willesden Junction, N.W. 10, to their works at Taunton, to which address they request that all correspondence and inquiries should be sent. The accounts department, however, will remain at Willesden as heretofore.

Mr. H. R. Summers has vacated the secretaryship of the British Engineers' Association and is joining the board of Research and Development, Limited, the offices of which are at present at 25, Bedford-street, Strand; though we understand that the company will be moving shortly to larger premises to accommodate several of the subsidiary companies it has formed.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

1924.

WEDNESDAY AND THURSDAY, JANUARY 2ND AND 3RD.

Physical Society of London and the Optical Society.—Imperial College of Science and Technology, South Kensington, S.W. 7. Annual exhibition. 3 p.m. to 6 p.m. and 7 p.m. to 10 p.m.

WEDNESDAY, JANUARY 2ND.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, S.W. 1. Address by the incoming President, Mr. J. S Alford, M. Inst. C.E., 7.30 p.m.

THURSDAY, JANUARY 3RD.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment. Lecture on "Railway Electrification in Foreign Countries," by Dr. S. P. Smith. 6 p.m.

FRIDAY, JANUARY 4th.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Economy of Fuel by Removal of Soot from Boiler Tubes," by Mr. L. Manico. 7.30 p.m.

TUESDAY, JANUARY 8TH.

Institute of Marine Engineers.—85/88, The Minories, Tower Hill, E. 1. "Modern Refrigerating Machines," by Mr. R. G. Reid. 6.30 p.m.

Junior Institution of Engineers.—Cannon Street Hotel, E.C. 4. Dance. 7 p.m.

FRIDAY, JANUARY 11TH.

British Electrical and Allied Industries Research Association.—Connaught Rooms, Great Queen-street, W.C. 2. Annual luncheon.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Paper, "Concrete Engineering," by Mr. C. O. Mourant, 7.30 p.m.

FRIDAY, JANUARY 18TH.

Institution of Locomotive Engineers (London).—College of Technology, Sackville-street, Manchester. Ordinary general meeting. 7 p.m.

FRIDAY, JANUARY 25TH.

Institution of Municipal and County Engineers.—Holborn Restaurant, W.C. 1. South-Eastern District dinner. 6.30 p.m.

FRIDAY, FEBRUARY 1ST.

University College, London, Engineering Society.—The College Refectory, Gower-street, W.C. 1. Annual Dinner and Conversazione.

The Royal Institution of Great Britain.—The following is the programme of lectures arranged for the before Easter session of the Royal Institution:—Friday evening discourses, at 9 p.m.: January 18th, Professor Henry E. Armstrong, F.R.S., "The Scientific Work of Professor Sir James Dewar, LL.D., D.Sc., F.R.S., Fullerian Professor of Chemistry (1877–1923);" January 25th, Sir Aston Webb, K.C.V.O., President of the Royal Academy, "The Future Development of London;" February 1st, Sir William Bragg, K.B.E., F.R.S., "Recent Research on Crystalline Structure;" February 8th, Sir Arthur Evans, F.R.S., Professor of Prehistoric Archæology, University of Oxford, "Recent Lights on the Minoan Art of Crete;" February 15th, Dr. J. H. Jeans, F.R.S., Secretary of the Royal Society, "The Origin of the Solar System;" February 22nd, Dr. G. Elliot Smith, F.R.S., Professor of Anatomy, University of London, "The Human Brain;" February 29th, not yet announced; March 7th, Dr. Walter Rosenhain, F.R.S., Superintendent of Metallurgy Department, National Physical Laboratory, "The Inner Structure of Alloys;" March 14th, Dr. J. W. Mackail, LL.D., Hon. Fellow of Balliol College, Oxford, "The Pilgrim's Progress;" March 21st, Sir Frederick Keeble, F.R.S., Sherardian Professor of Botany and Fellow of Magdalen College, Oxford, "The Plant Commonwealth and its Government;" March 28th, Dr. Hugh Maclean, Professor of Medicine, University of London, "Insulin;" April 4th, Sir Ernest Rutherford, F.R.S., Professor of Natural Philosophy and Cavendish Professor of Experimental Physics, University of Cambridge, "The Nucleus of the Atom;" and April 11th, Dr. Jocelyn Thorpe, F.R.S., Professor of Organic Chemistry, Imperial College of Science and Technology, "Colours, Stains and Dyes." General courses of lectures, Tuesdays and Thursdays at 5.15 p.m., Saturdays at 3 p.m.:—Tuesdays, January 15th, 22nd, "Drug Addictions," by Dr. Walter E. Dixon, F.R.S., Professor of Pharmacology, King's College, London; Tuesdays, January 29th, February 5th, "What is Heredity?" by Dr. Arthur Dendy, F.R.S., Professor of Zoology, University of London (King's College); Tuesdays, February 12th, 19th, 26th, March 4th, "The Respiratory Pigments in Animal Life and their significance," by Joseph Barcroft, F.R.S., Fellow of King's College, Fullerian Professor of Physiology; Tuesdays, March 11th, 18th, "Recent Investigation Concerning the Safety of Railway Bridges," by Major C. E. Inglis, A.M. Inst. C.E., Professor of Engineering, University of Cambridge; Tuesdays, March 25th, April 1st, 8th, "Ballads," by George Gordon, Merton Professor of English Literature, University of Oxford; Thursdays, January 17th, 24th, 31st, "Straws from Cumberland Market," by Walter Sickert; Thursdays, February 7th, 14th, 21st, 28th, "The Crystalline Structure of Organic Substances," by Sir William Bragg, K.B.E., F.R.S.; Thursdays, March 6th, 13th, (I.) "Modes of Volcanic Action," (II.) "Types of Volcanic Structures," by Dr. John S. Flett, F.R.S., Director of H.M. Geological Survey and Museum of Practical Geology; Thursdays, March 20th, 27th, "Evolution To-day," by D. S. M. Watson, Jodrell Professor of Zoology and Comparative Anatomy, University of London; Thursdays, April 3rd, 10th, "Scientific Research on Sea Fisheries," by Dr. E. J. Allen, F.R.S., Secretary of the Marine Biological Association and Director of the Plymouth Laboratory; Saturdays, January 19th, 26th, February 2nd, (I.) "The Mechanical Reproduction of Music," by Reginald Reynolds; (II.) "The Couperin Dynasty," (III.) "The Influence upon Composition of Improvements in Musical Instruments," by William Wallace; Saturdays, February 9th, 16th, "The Last Years of the Scottish Parliament," by Dr. Robert S. Rait, Historiographer Royal for Scotland; Saturdays, February 23rd, March 1st, (I.) "Imaginative Prose," (II.) "Character in Fiction," by Walter De La Mare; Saturdays, March 8th, 15th, 22nd, 29th, "Properties of Gases in High and Low Vacua," by Sir Ernest Rutherford, F.R.S.; and Saturdays, April 5th, 12th, (I.) "Aristotle as a Biologist," (II.) "Leonardo da Vinci as a Man of Science," by Dr. Charles Singer, Lecturer on the History of Medicine, University of London, University College.

END OF VOL. CXXXVI.

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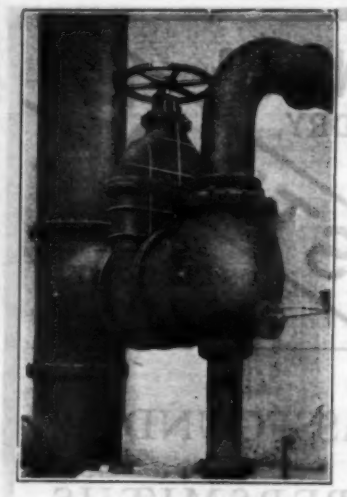

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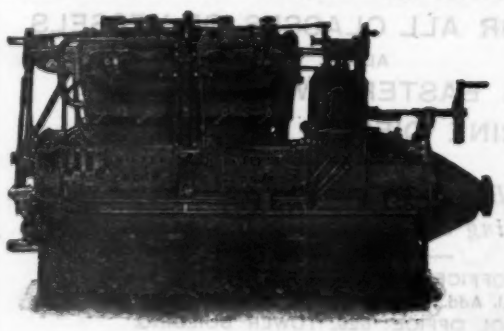

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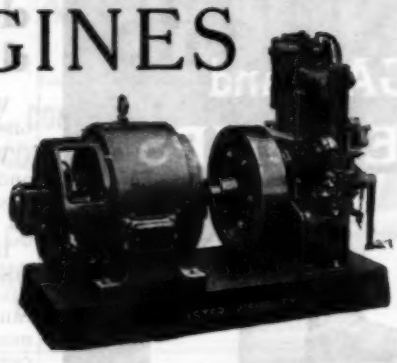

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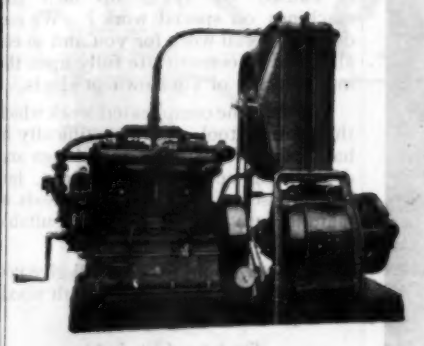

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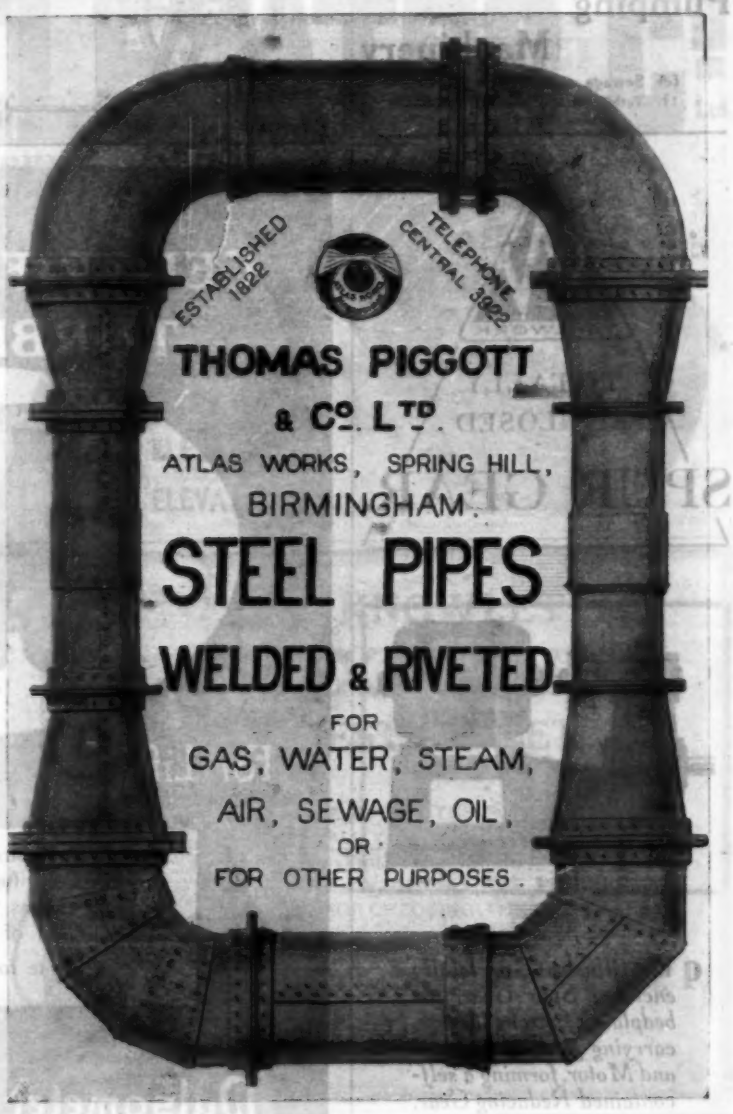

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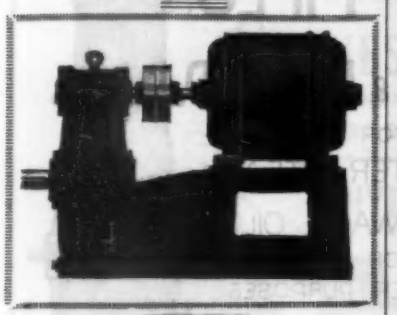

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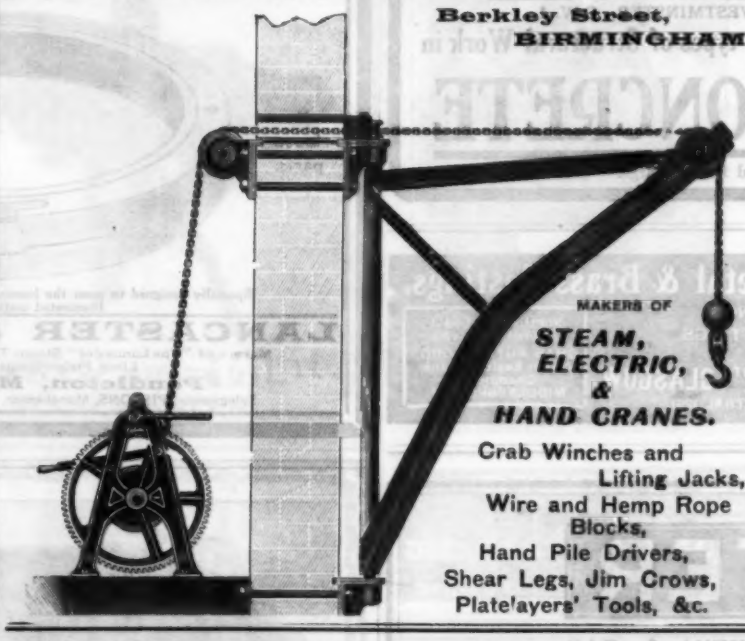

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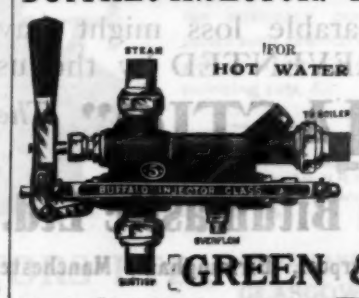

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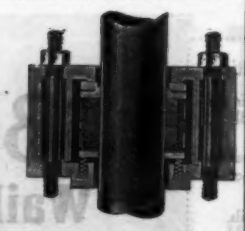

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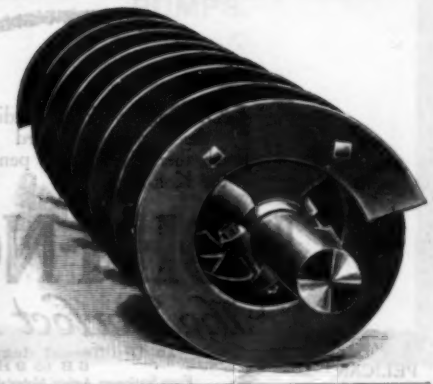

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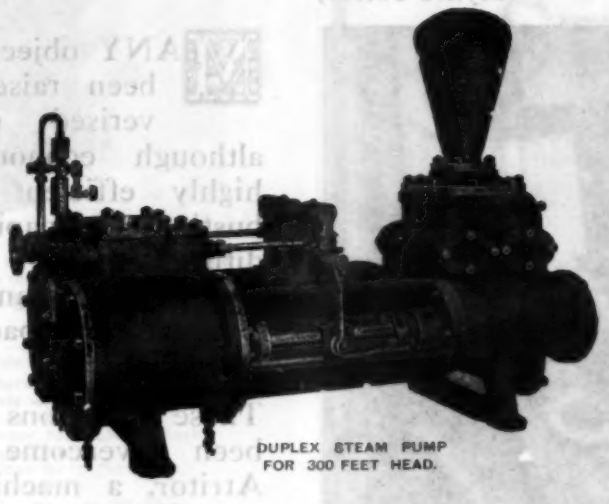

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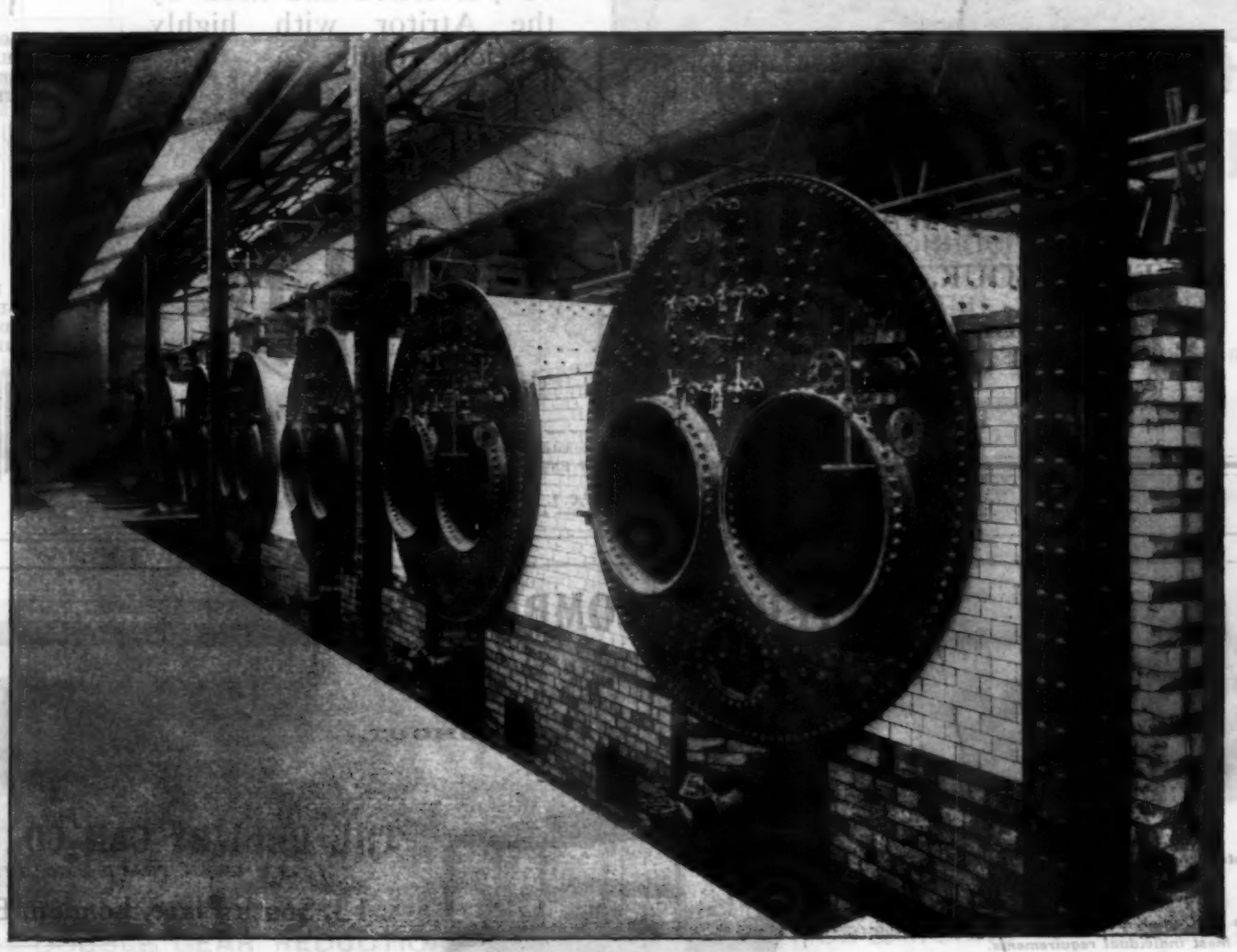

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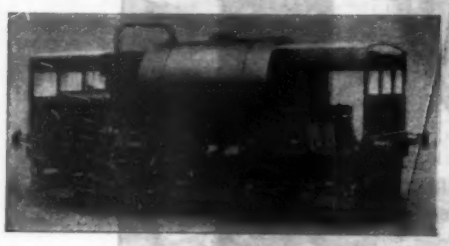

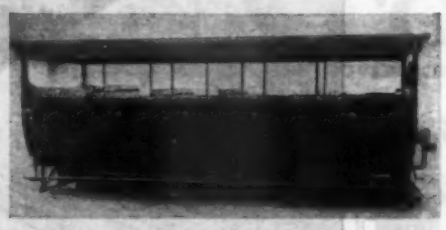

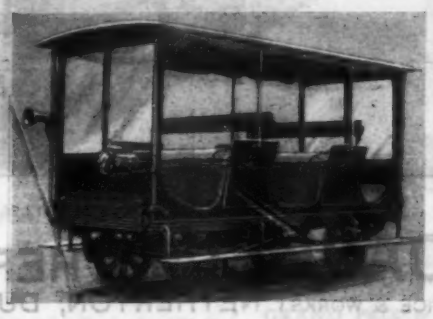

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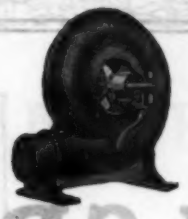

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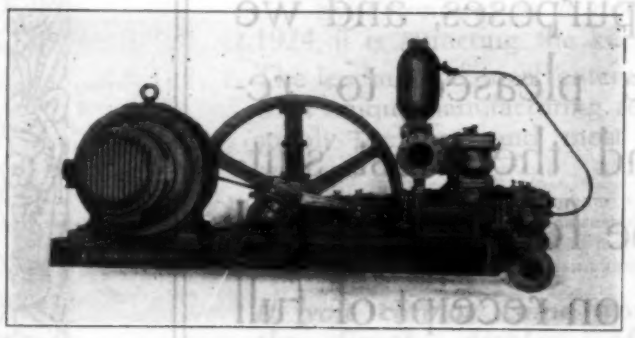

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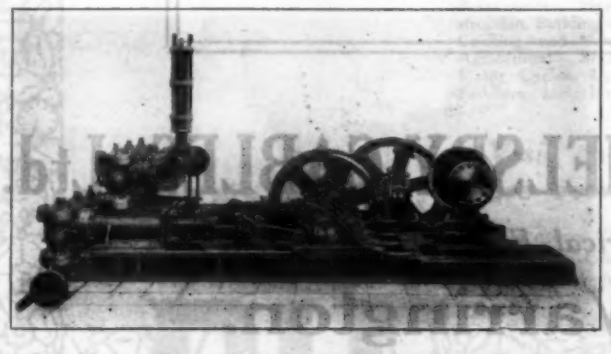

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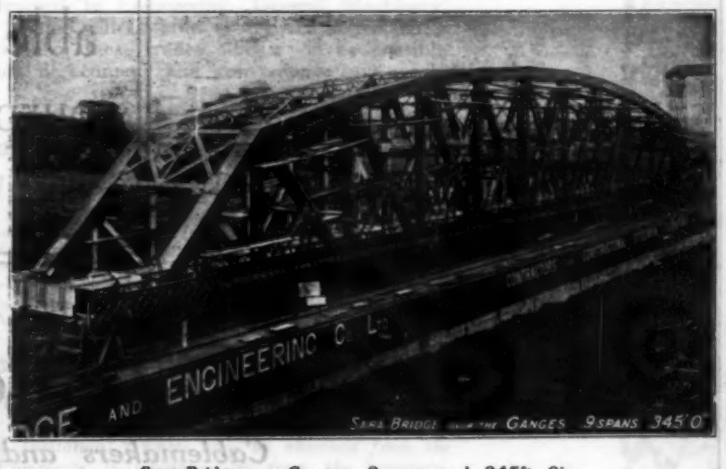

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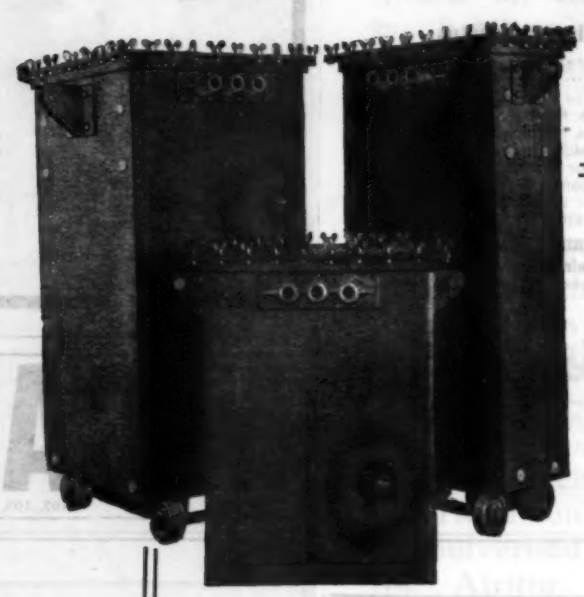

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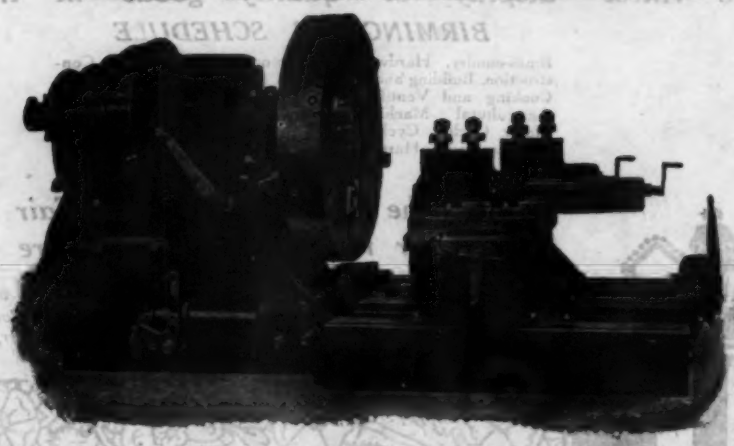

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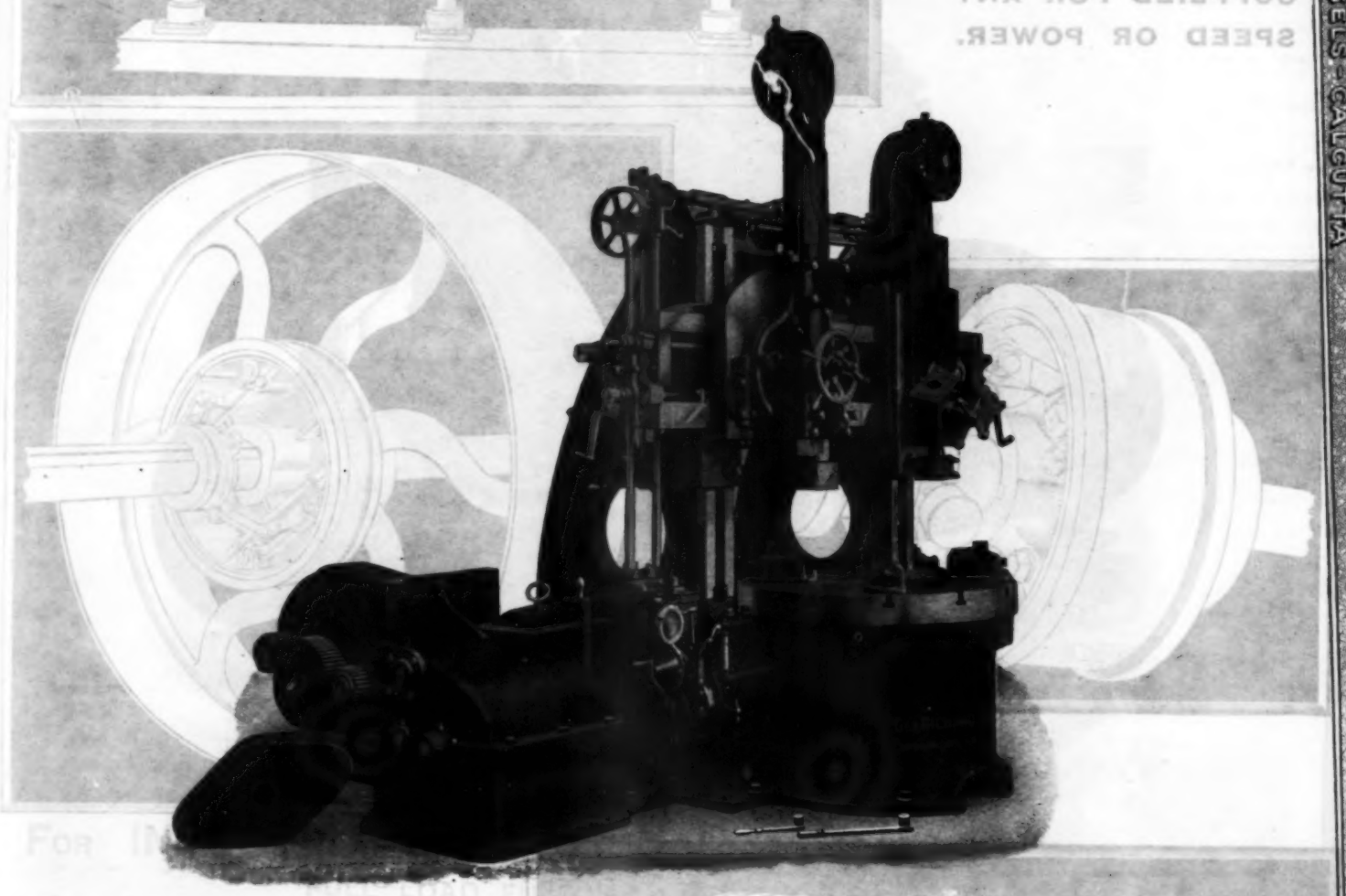

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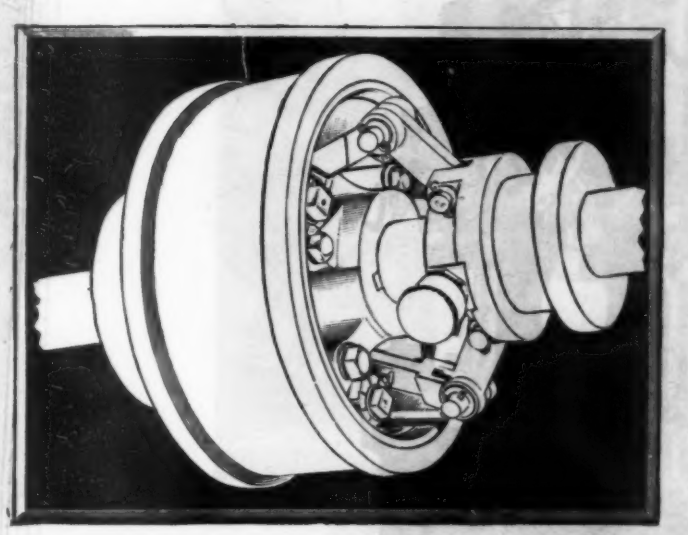

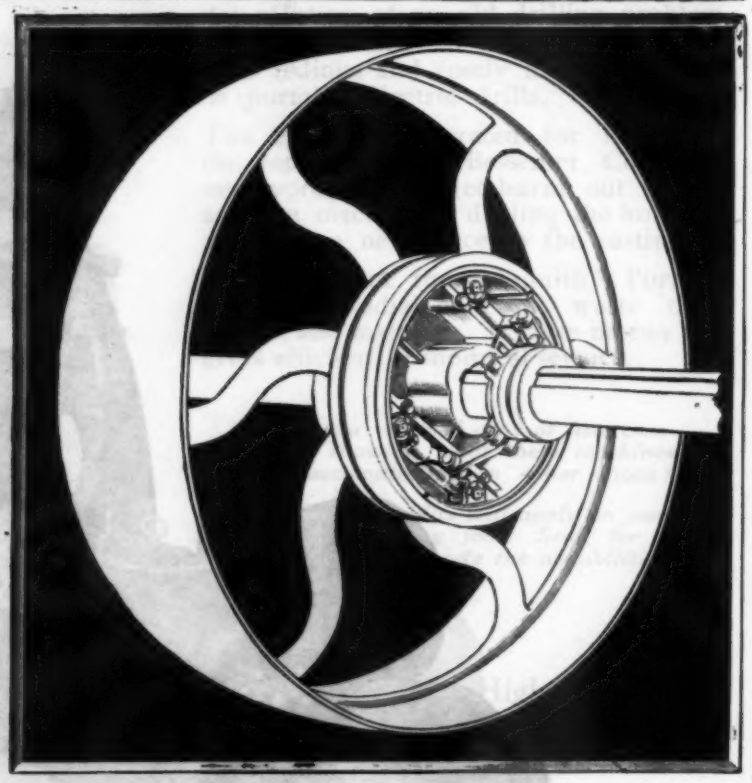

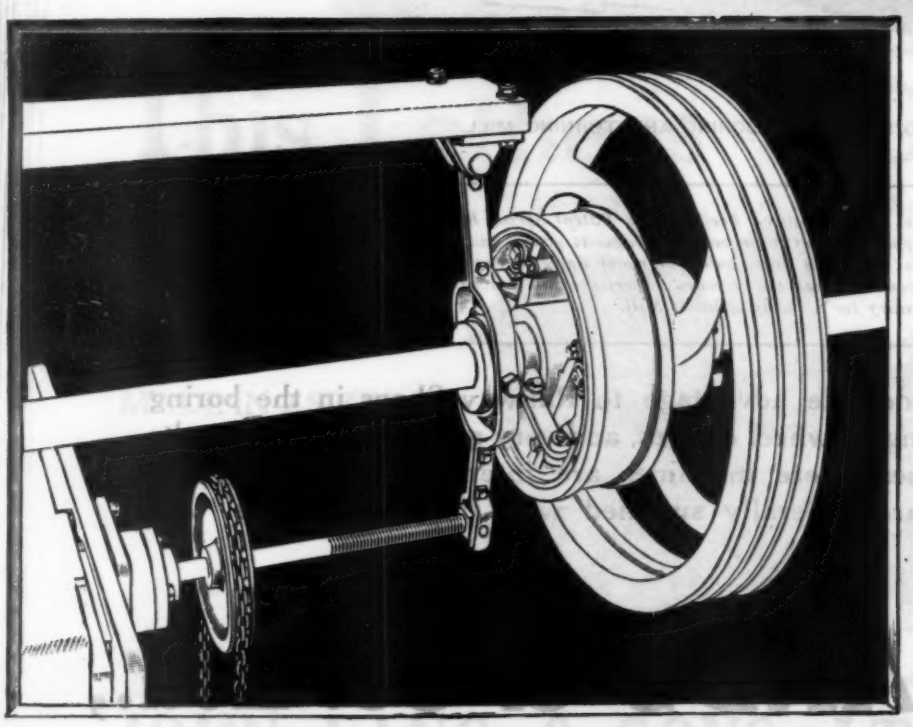

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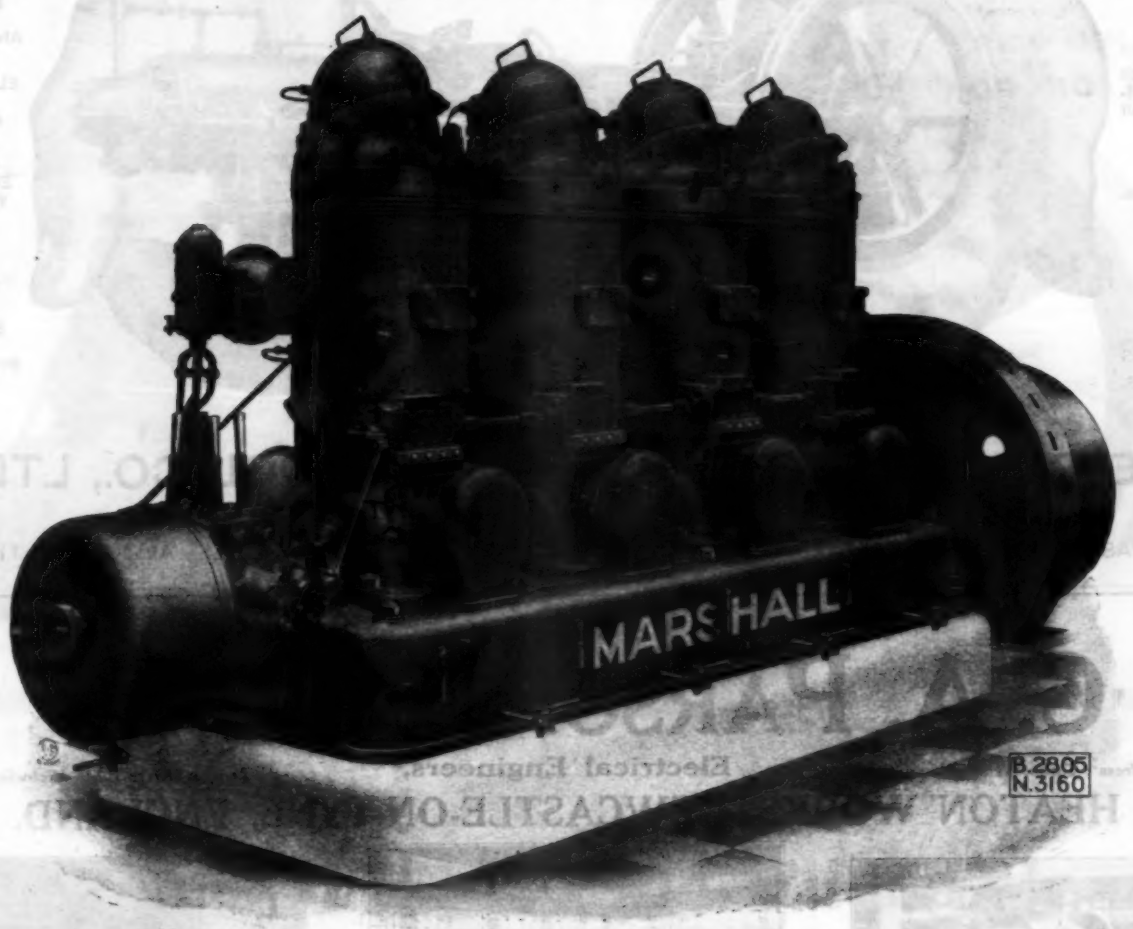

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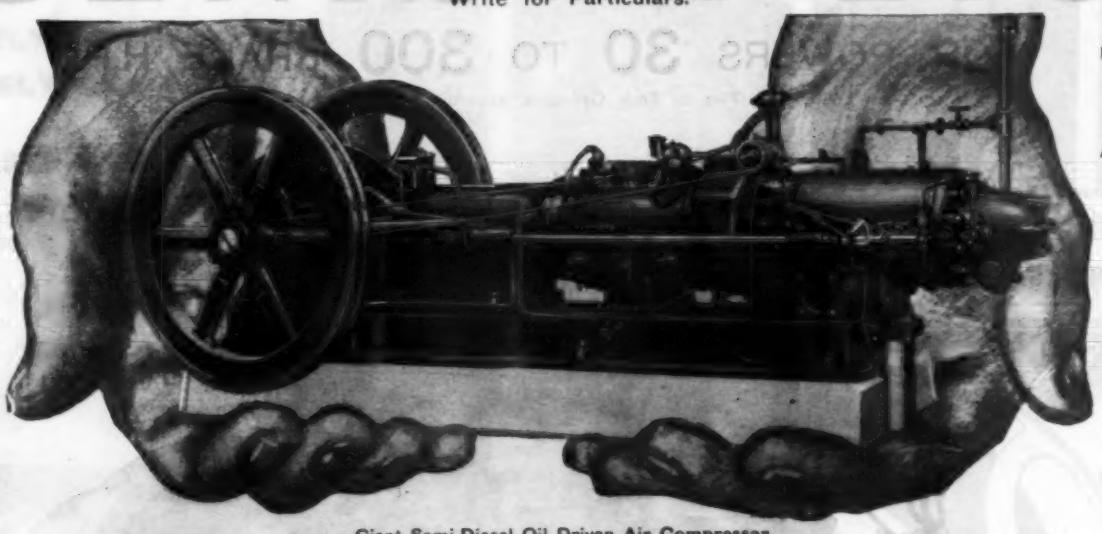

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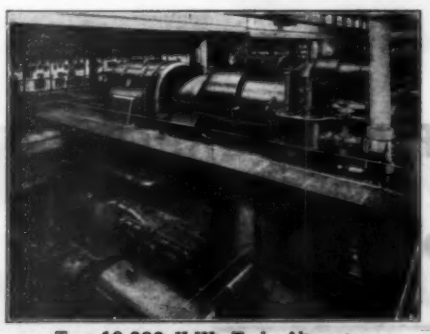

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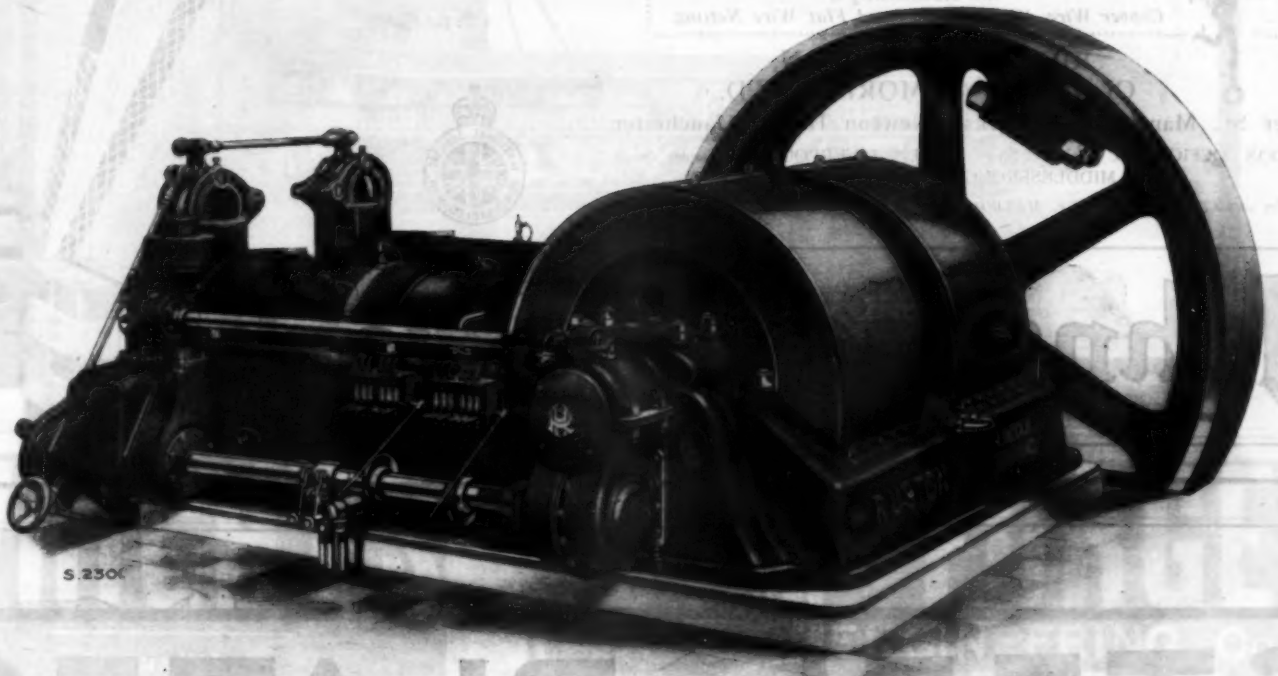

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Consumption from ·4 lbs. per BHP. Hour Guaranteed.

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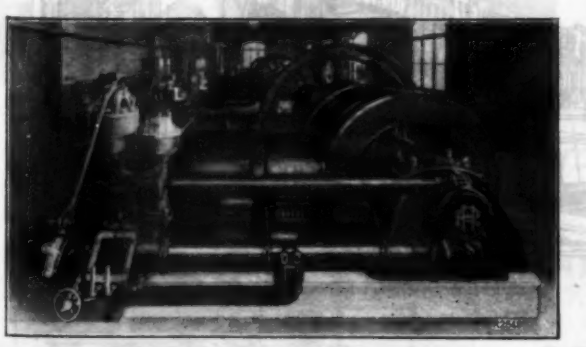

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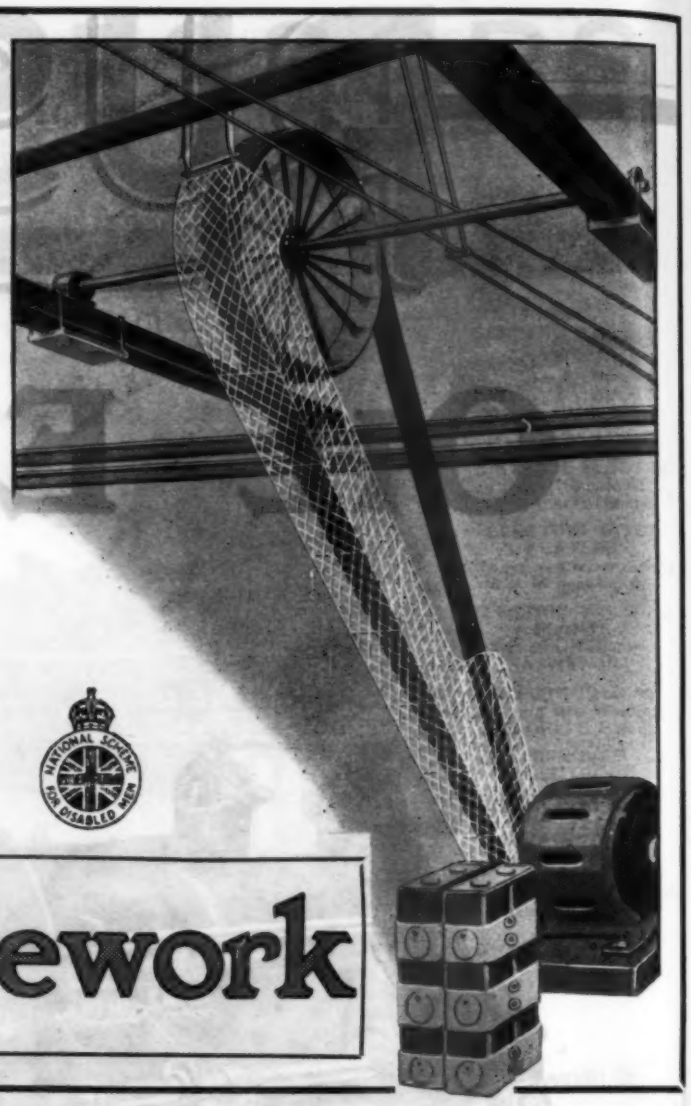

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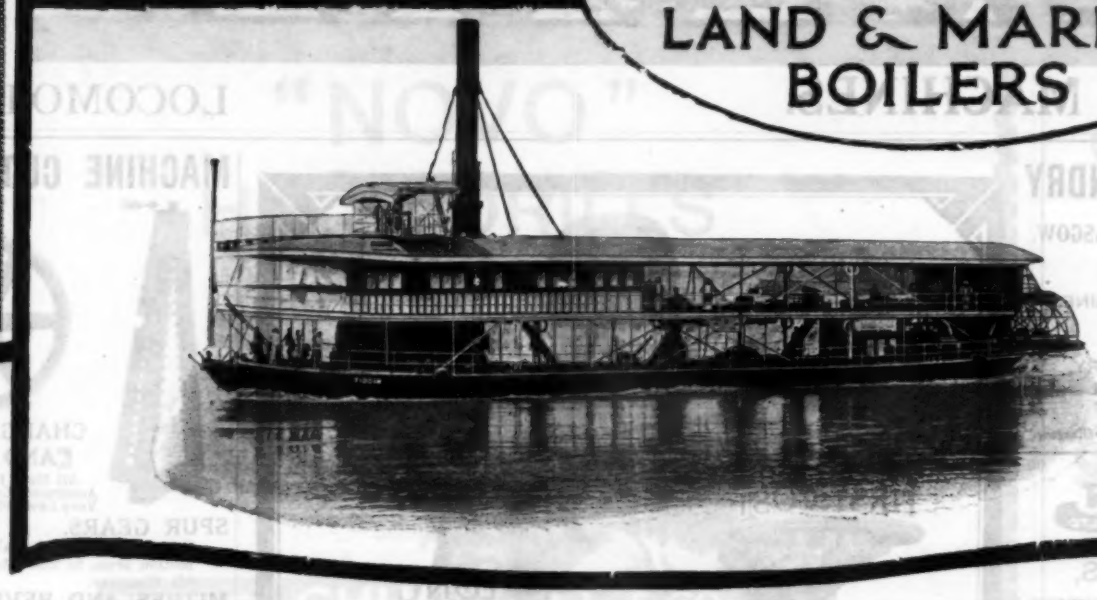

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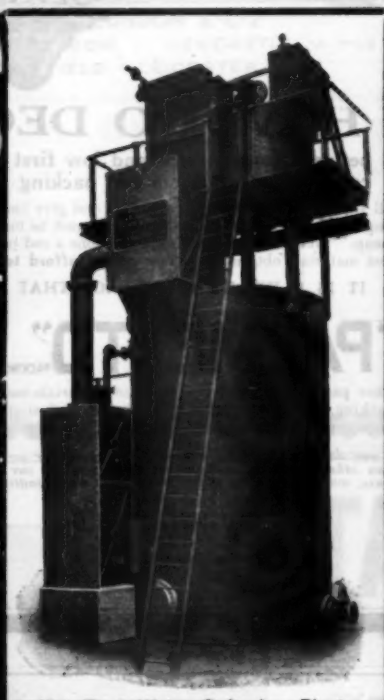

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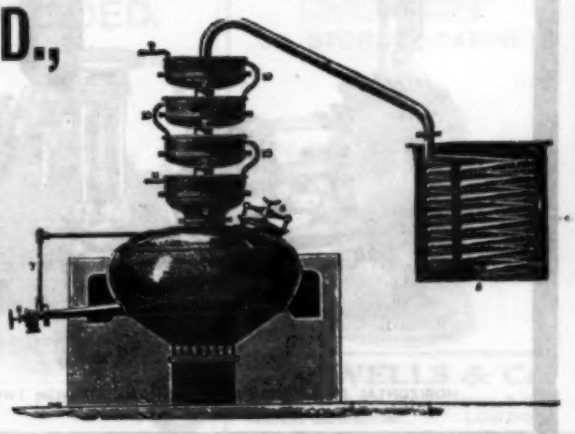

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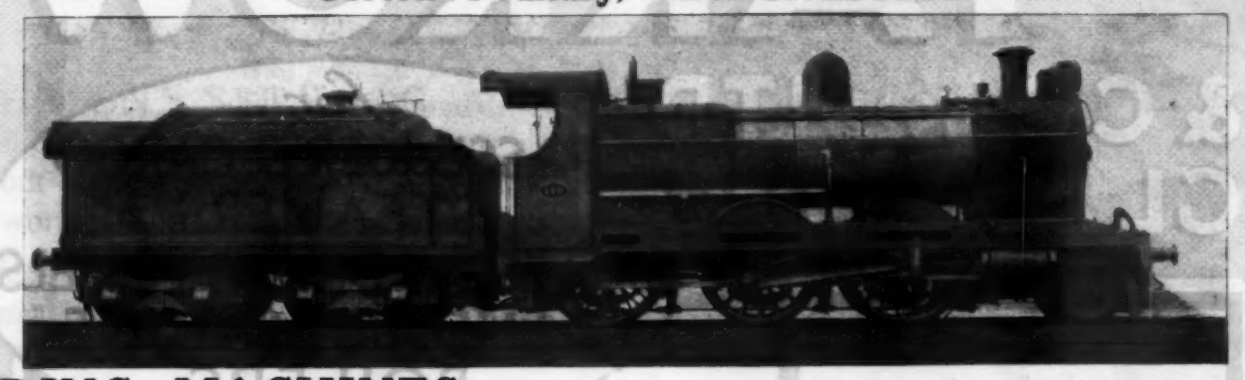

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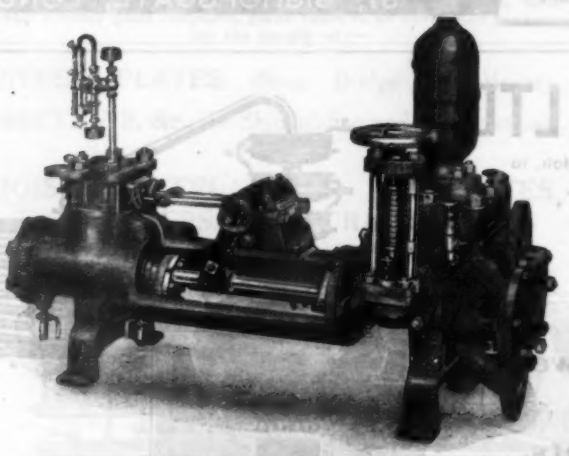

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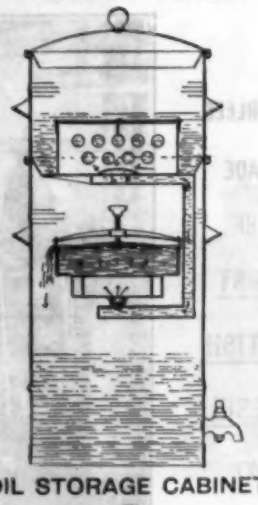

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Mirrlees Surface Condensing Plant

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"MIRRLEES DIESEL" ENGINES USE AIR INJECTION BECAUSE IT GIVES

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1	25 Ton	,, ,,	55	6	Span
1	20 Ton	,, ,,	62	0	Span
1	10 Ton	,, ,,	46	8	Span
1	10 Ton	,, ,,	33	5	Span
1	10 Ton	,, ,,	32	9	Span
1	10 Ton	,, ,,	26	8½	Span
1	10 Ton	,, ,,	16	11	Span
1	5 Ton	,, ,,	85	0	Span
1	5 Ton	,, ,,	33	6	Span
1	5 Ton	Overhead Slab Charger	62	4	Span
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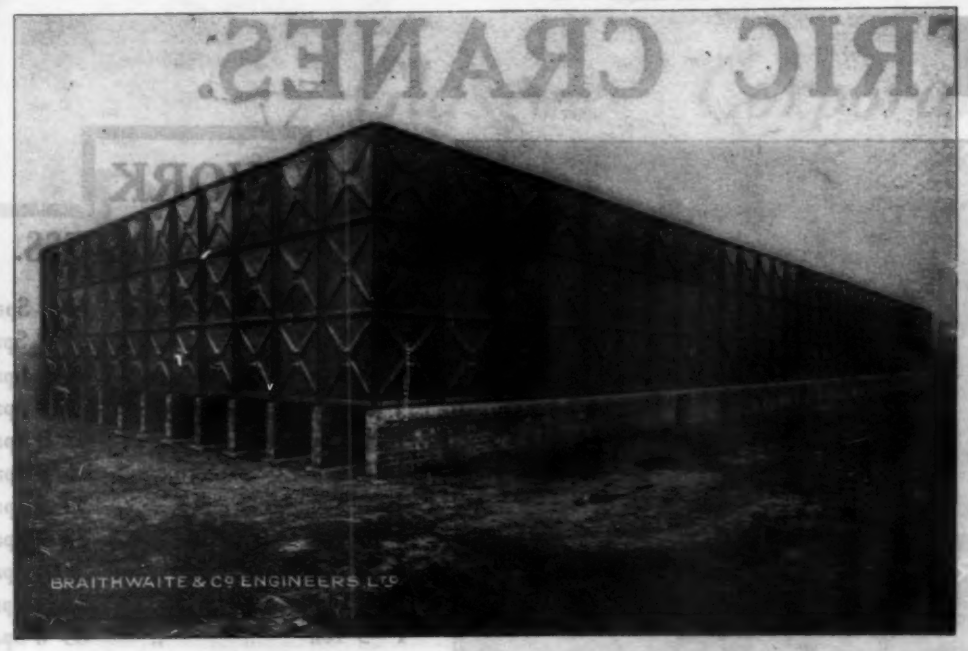

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PRESSED STEEL TANKS
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These tanks can be quickly and easily erected without special tackle or the employment of skilled labour

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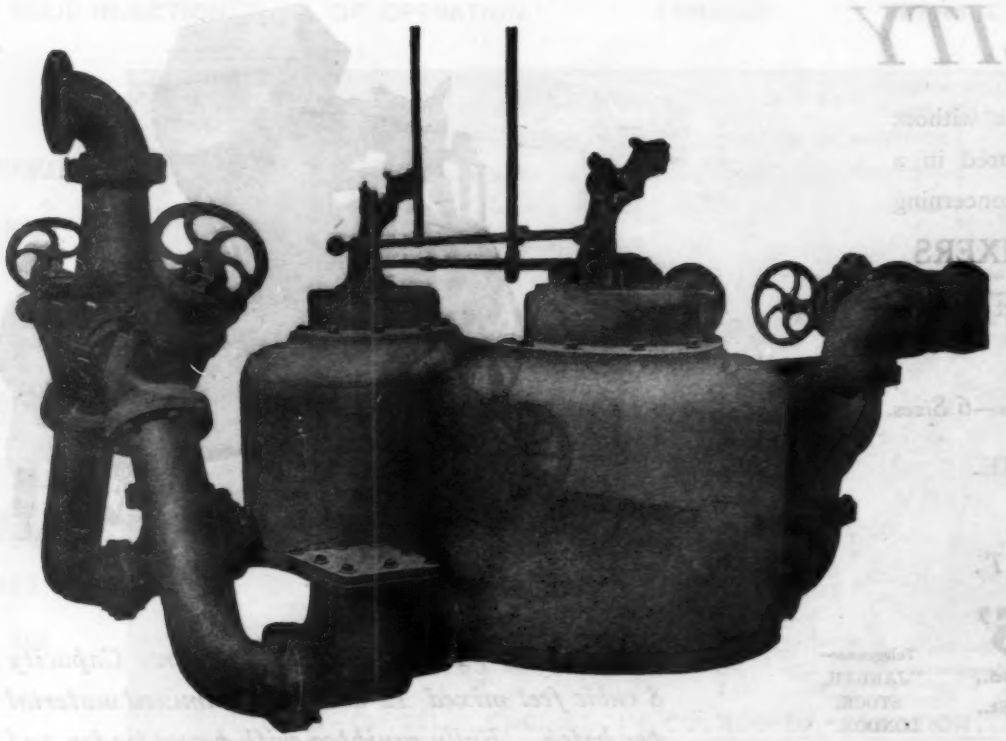

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OPERATION CAN BE ARRANGED FROM EXISTING POWER PLANT
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An Engineering Firm writes:—
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STEEL & IRON FORGINGS, STEEL CASTINGS,

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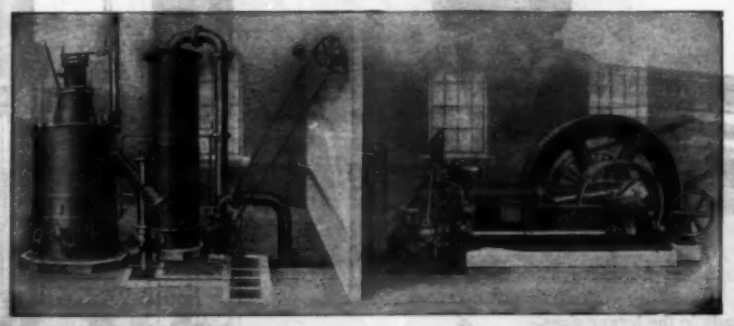
23" dia. x 31' 6" long. Finished weight 40 tons.

REPAIR WORK A SPECIALITY.



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POWER FROM WASTE

A Crossley Gas Engine combined with a Crossley Producer Plant is the most economical method of generating your power. This is particularly the case when waste fuels, such as those indicated, are available; and the saving when coal is burnt is also enormous, as in a Crossley Gas Plant each lb. of coal is made to yield its maximum energy. Full particulars will be supplied on request.

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Bituminous Coal.
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Peat.
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GAS ENGINES from 4 to 5000 B.H.P.
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AND HAND PUMPS FOR WATER, ACIDS, AND ALL LIQUIDS TO ALL PRESSURES.

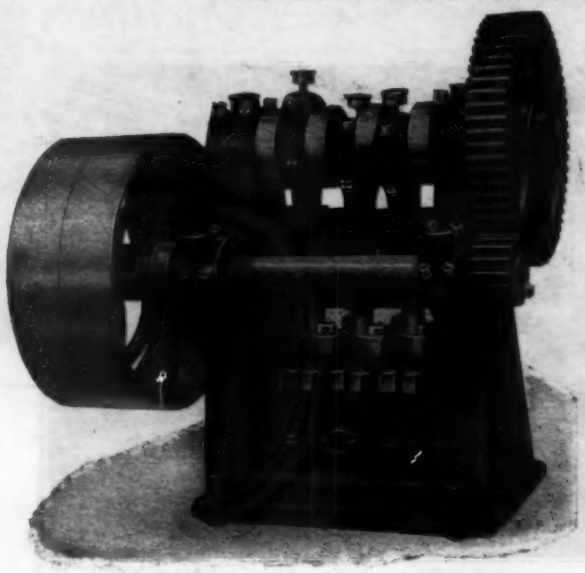


Fig. 7159.—BAILEY'S HYDRAULIC THREE-THROW PUMP.
For all pressures and capacities.

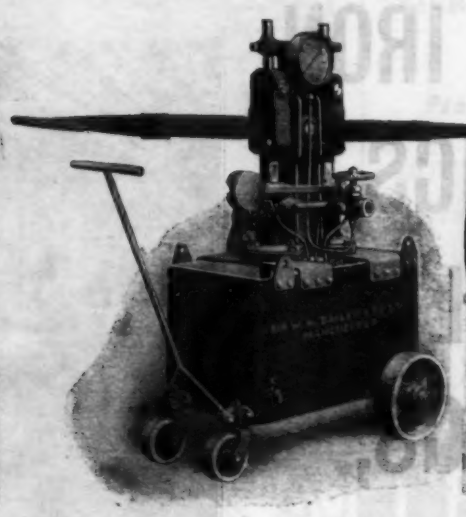
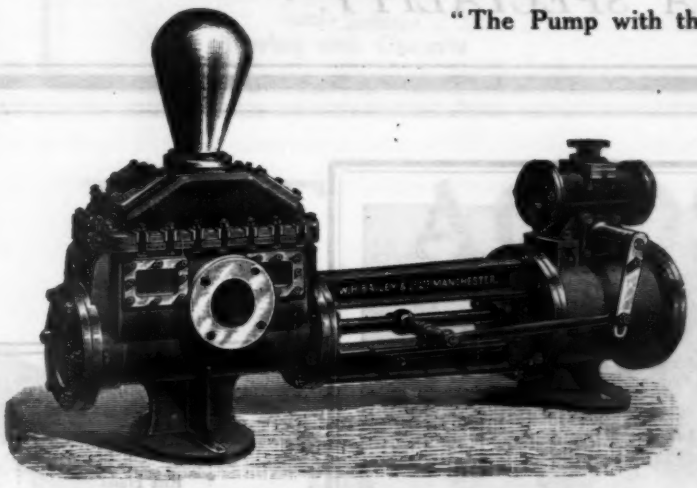


Fig. 5174.—"ADMIRALTY" TEST PUMP.
Of large capacity, for Pressures to 800 lbs.
For Testing Boilers, Piping Installations, &c.

Fig. 7161.—HYDRAULIC PUMP AND ACCUMULATOR.

"DAVIDSON" PATENT STEAM PUMPS

"The Pump with the Simplest Slide-Valve."



No. 1 D.
"DAVIDSON" STEAM PUMP, as made in the larger sizes.
For Boiler Feeding, &c., to 150 lbs. Pressure.

Fig. 6a D.—"DAVIDSON" HIGH-PRESSURE DOUBLE RAM PUMP.
For High Lifts in Mines &c.

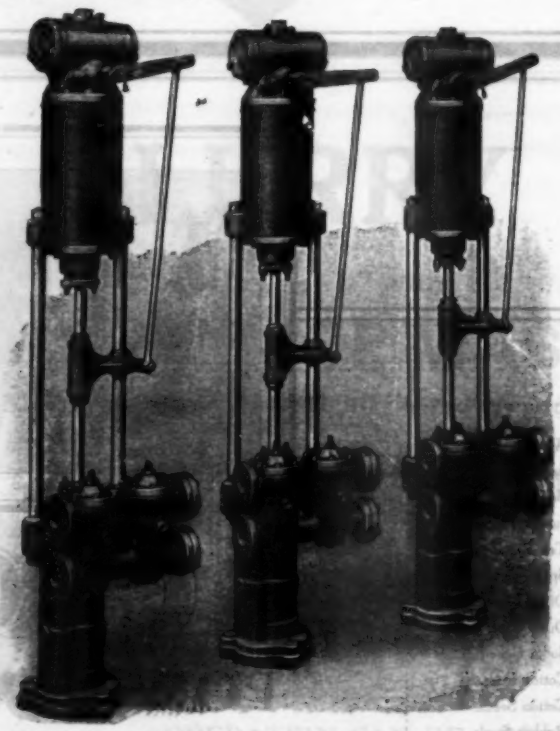


Fig. 50 D.—A Group of "Davidson" Patent Economical Boiler Feed Pumps.

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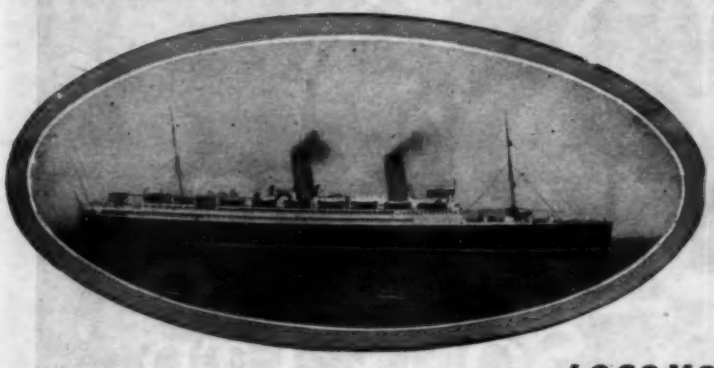

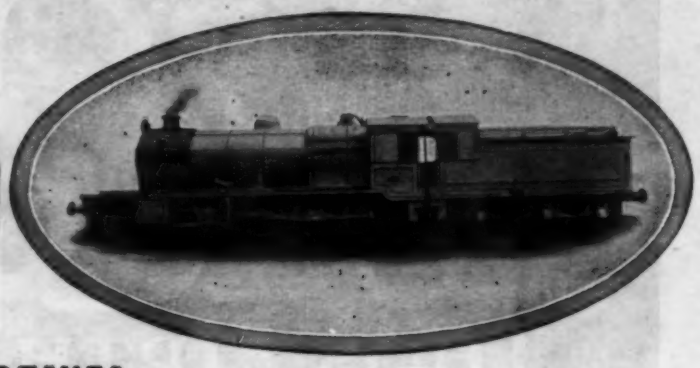

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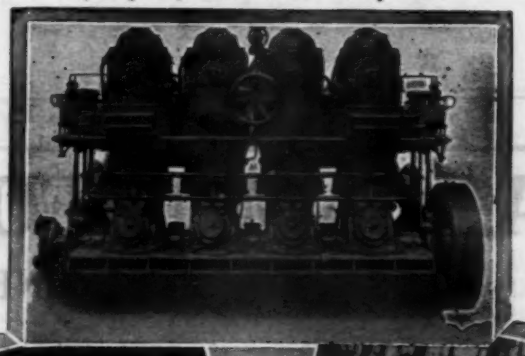

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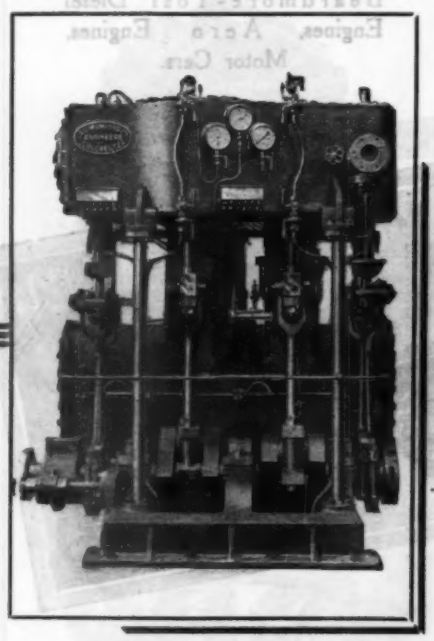

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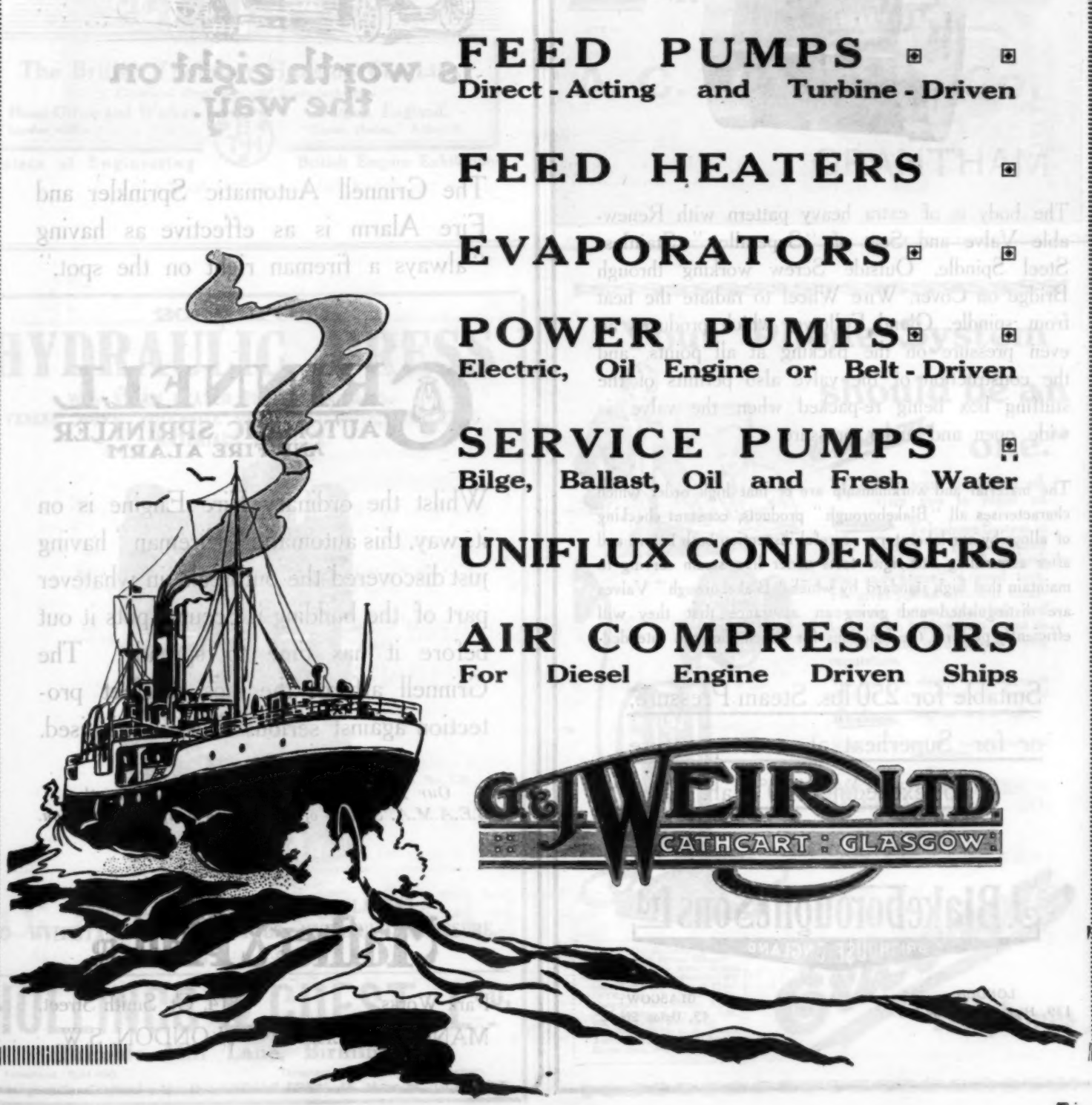

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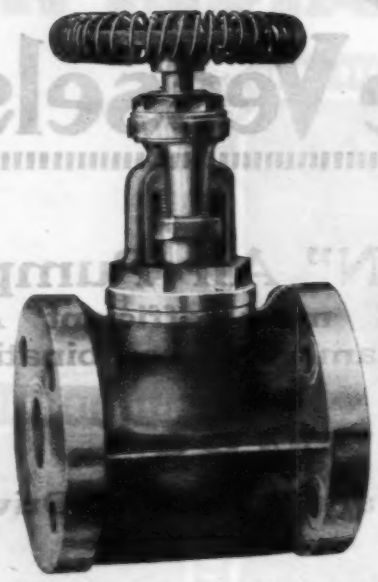

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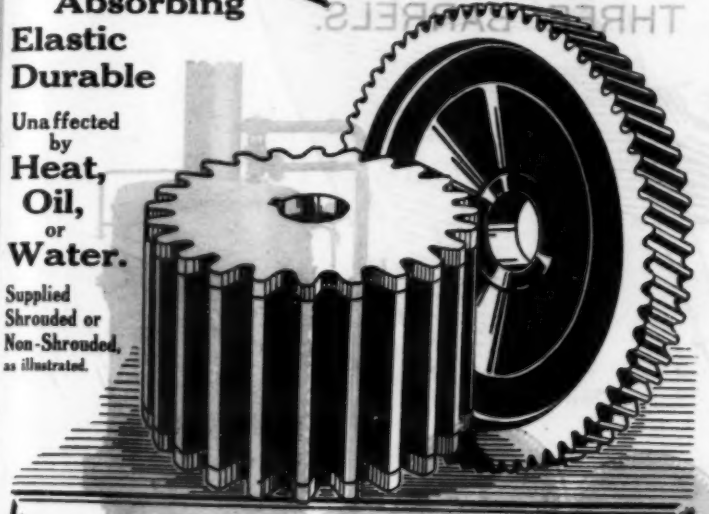

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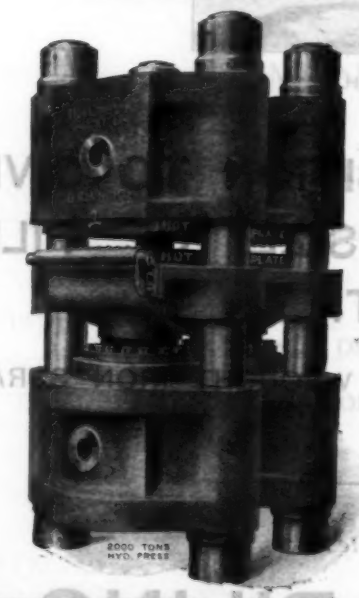

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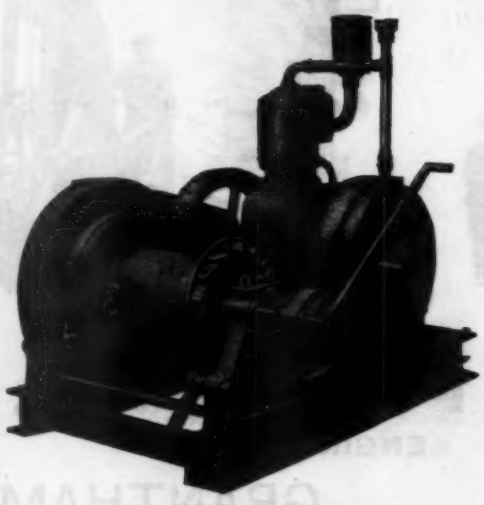

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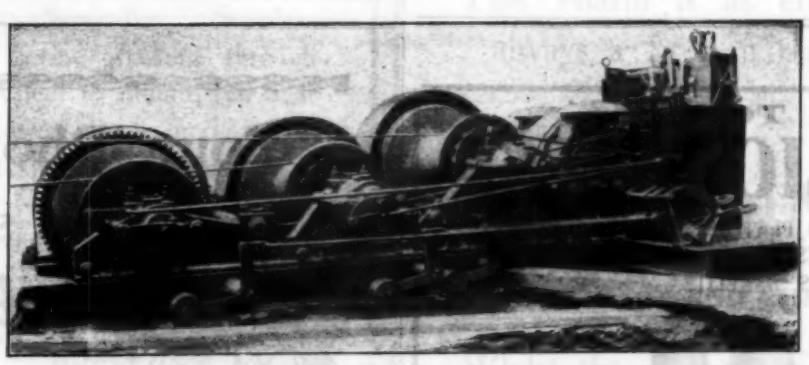

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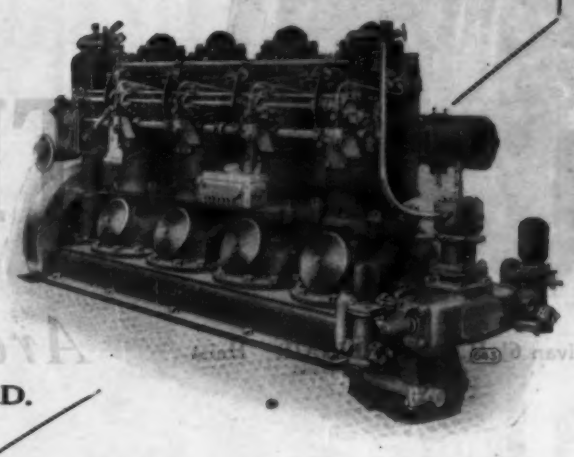

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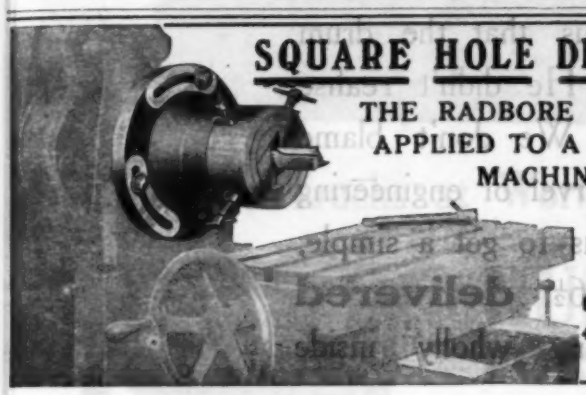

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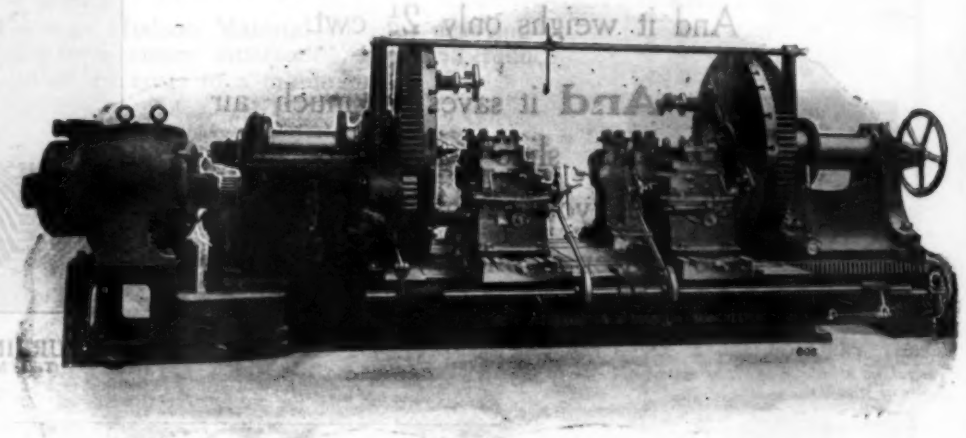

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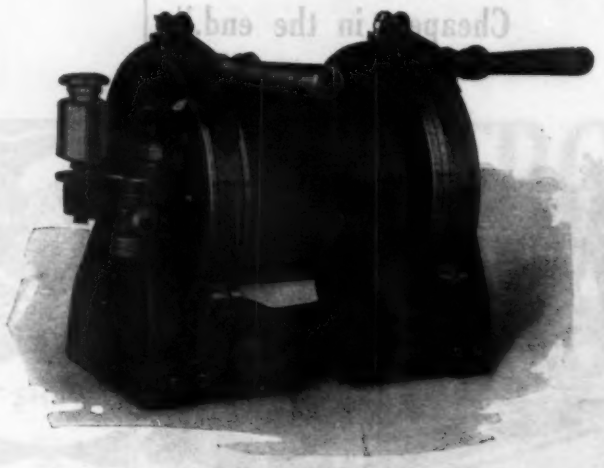

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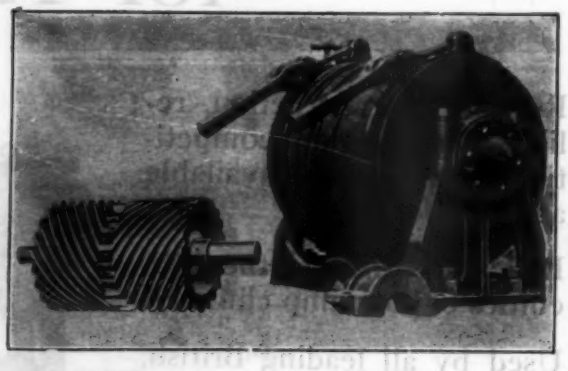

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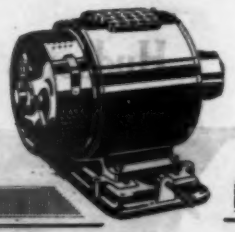

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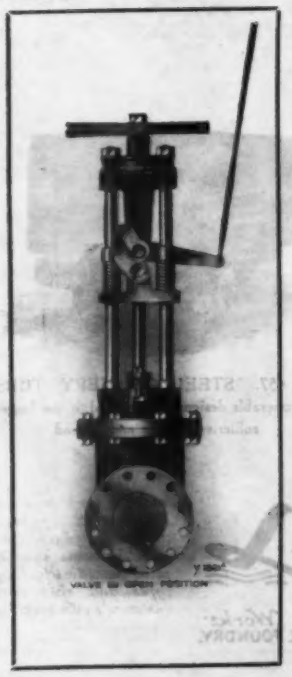

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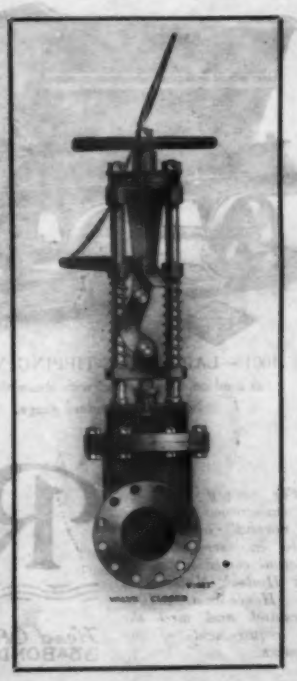

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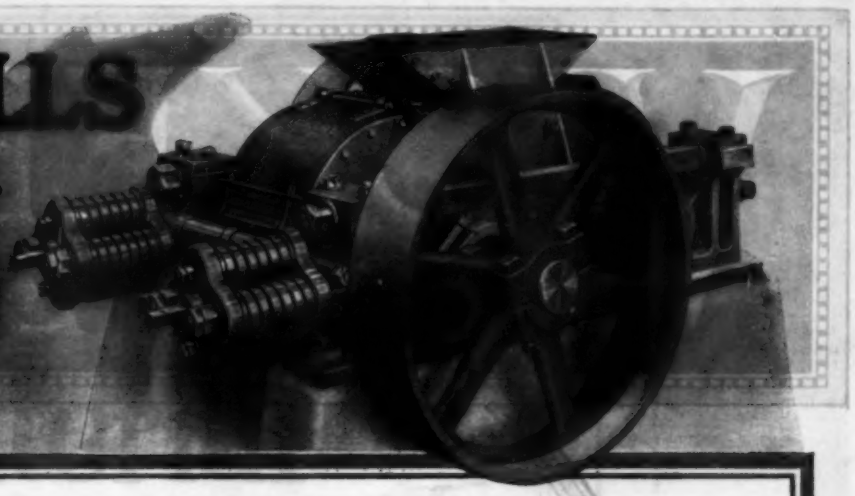

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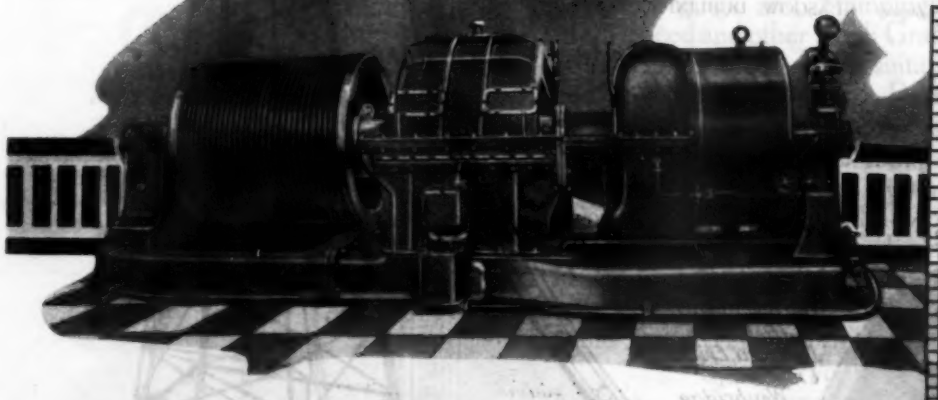

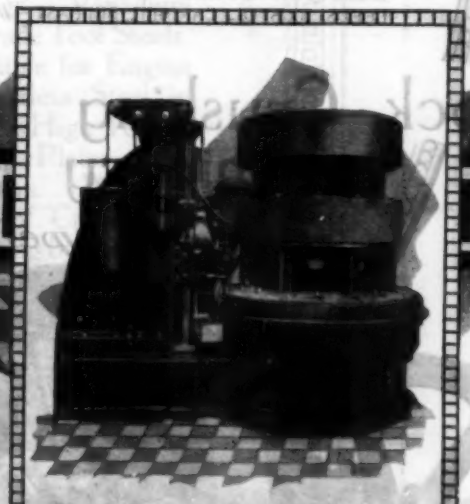

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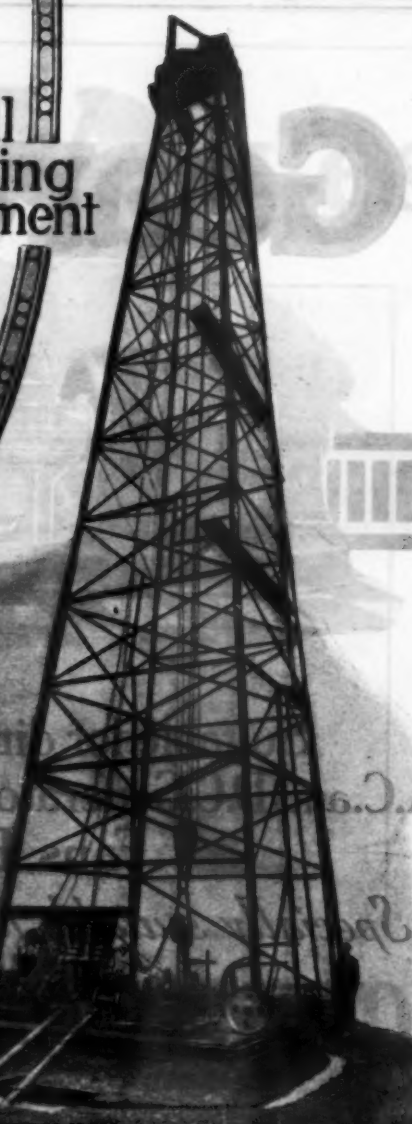

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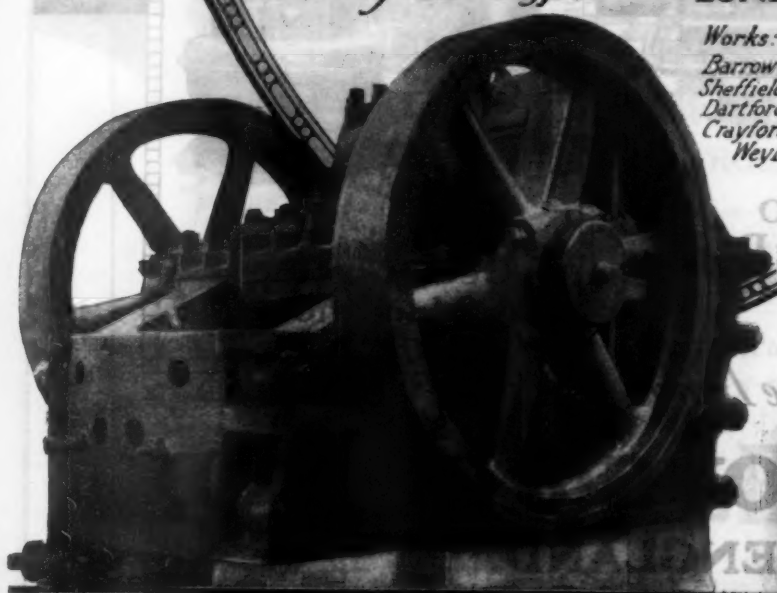

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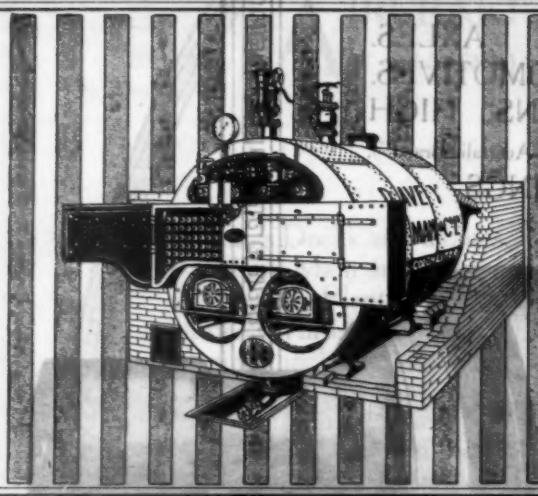

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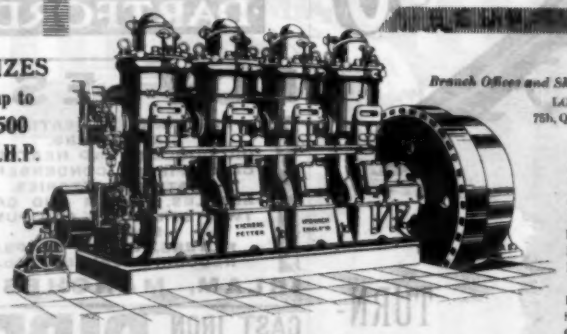

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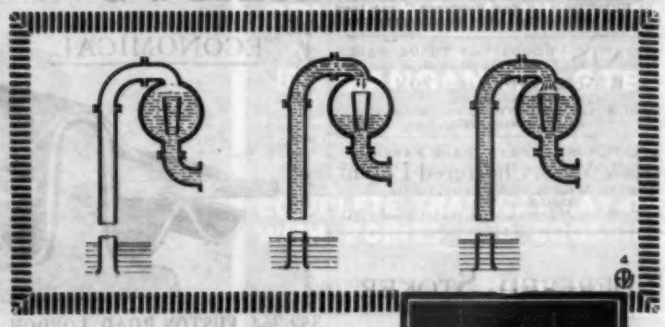

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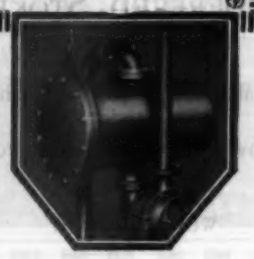

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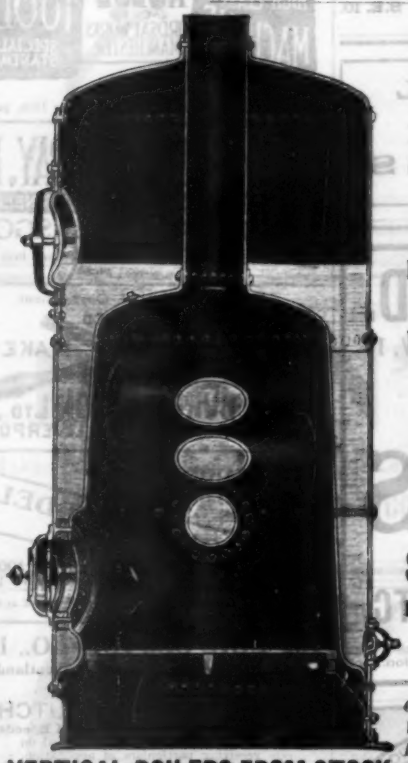

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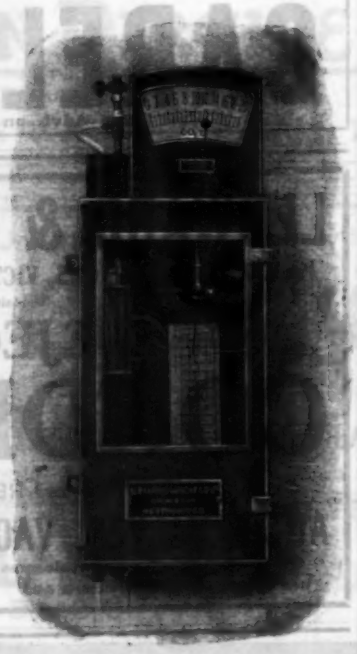

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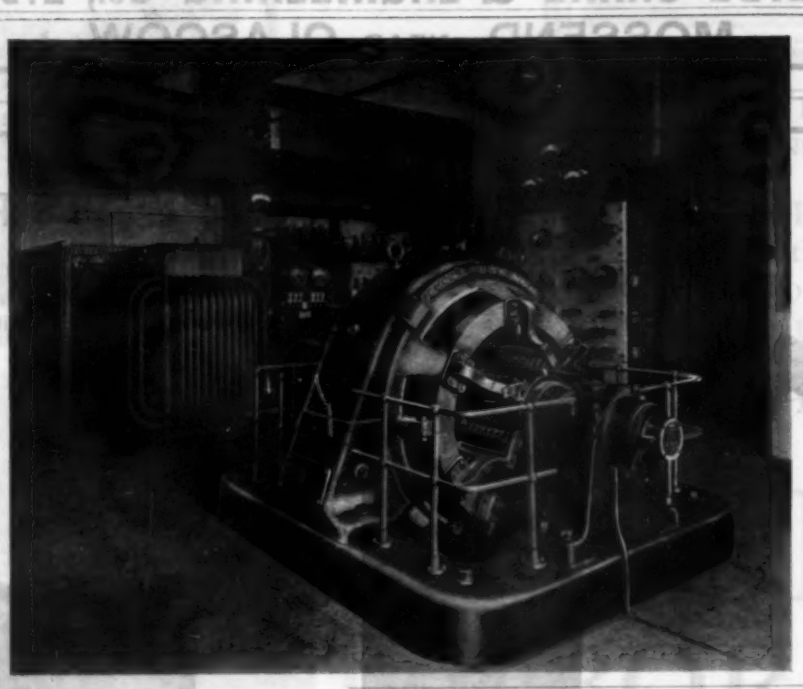

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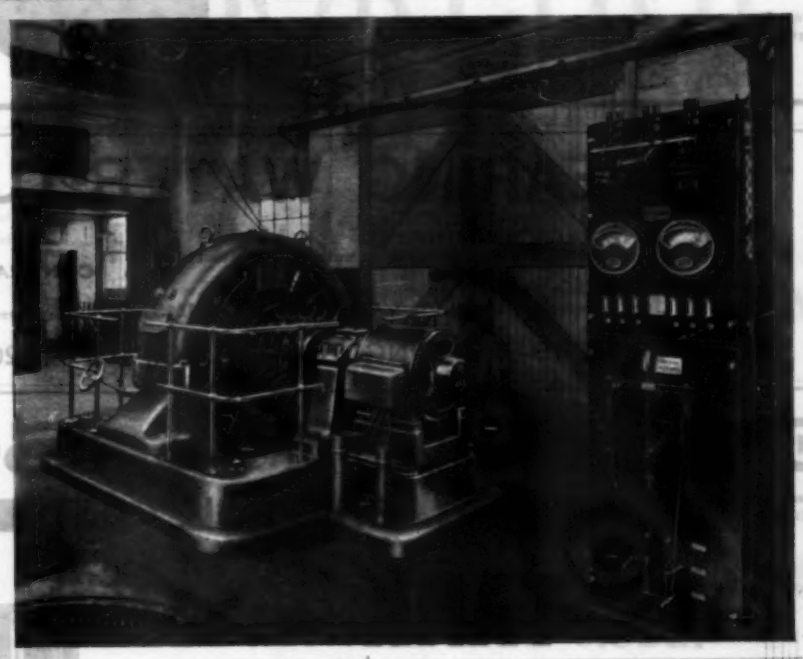

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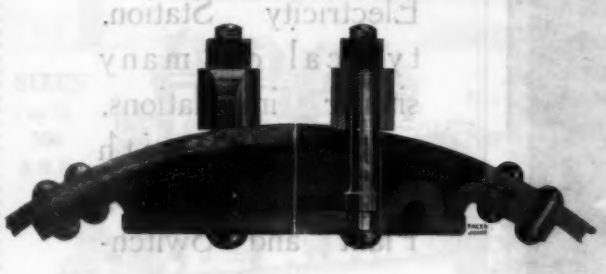

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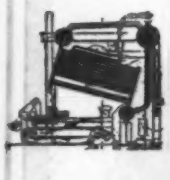

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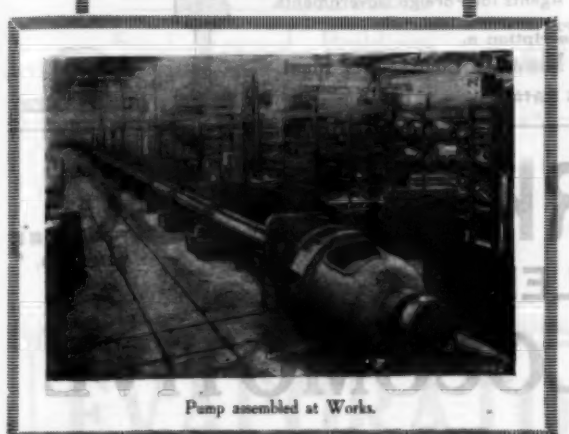
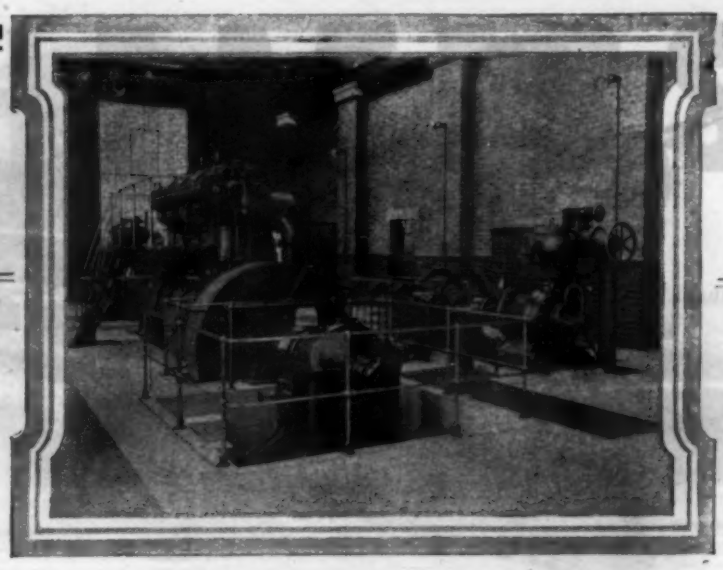


Pump assembled at Works.

Lowering first section of Delivery Shaft with Borehole Pump attached.

Placing final section of Delivery Shaft in position.



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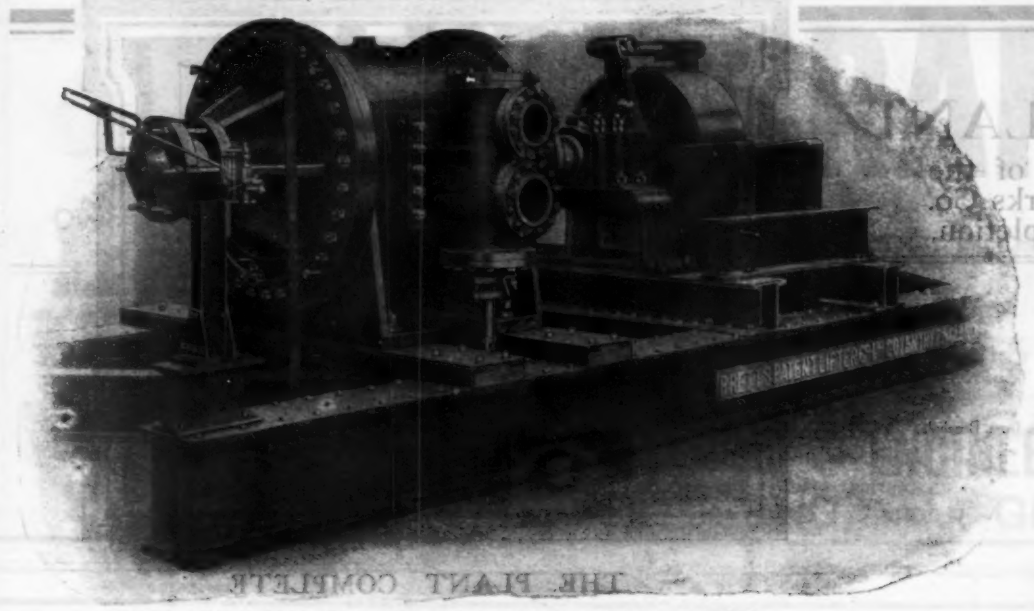

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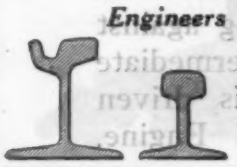

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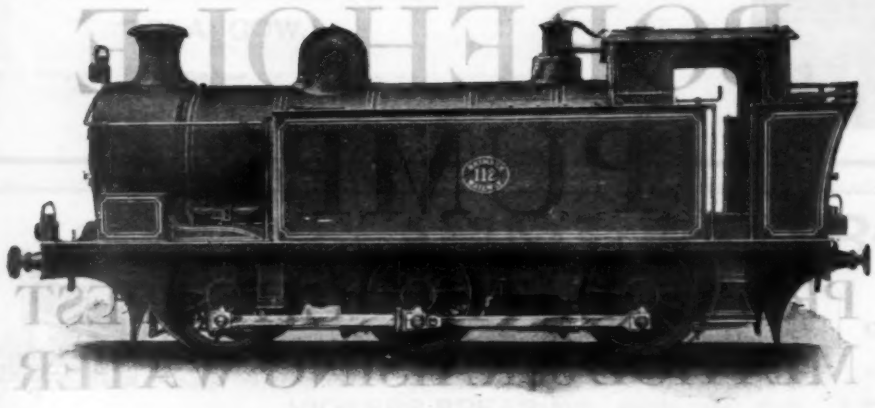

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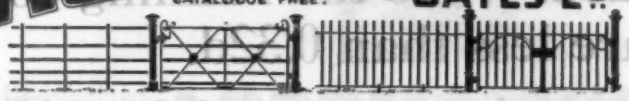

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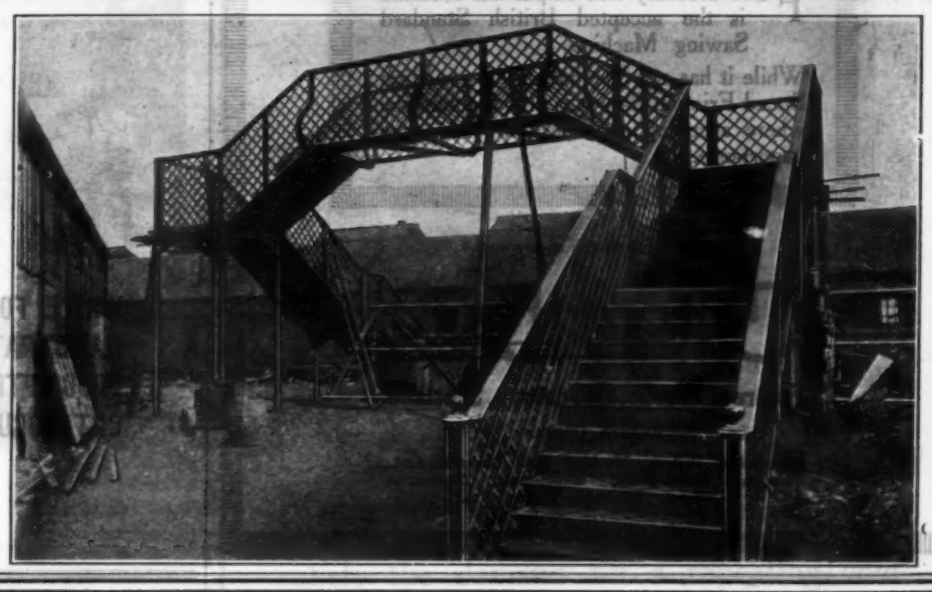

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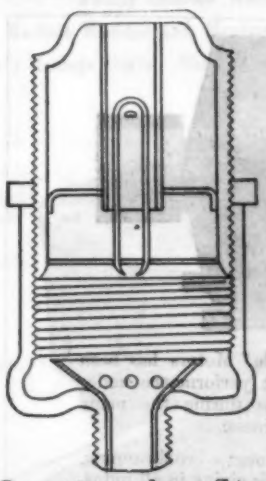

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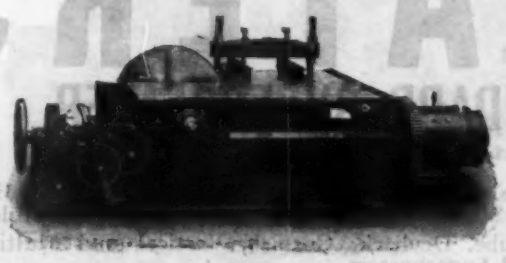

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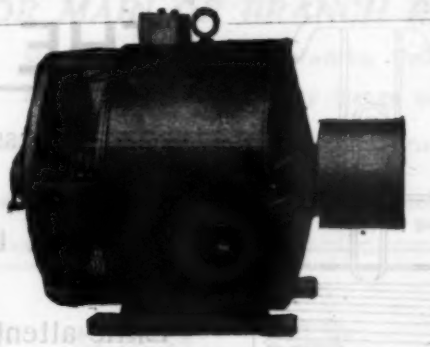

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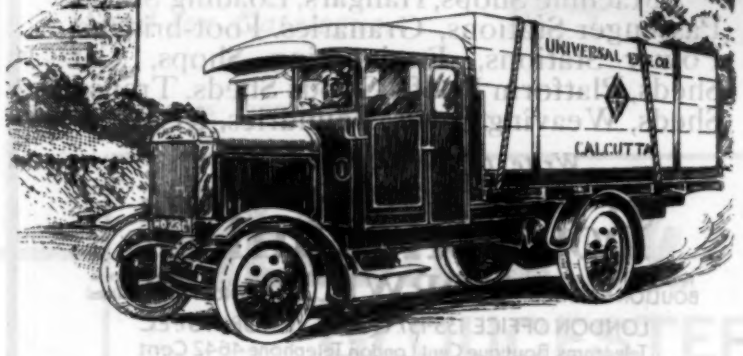

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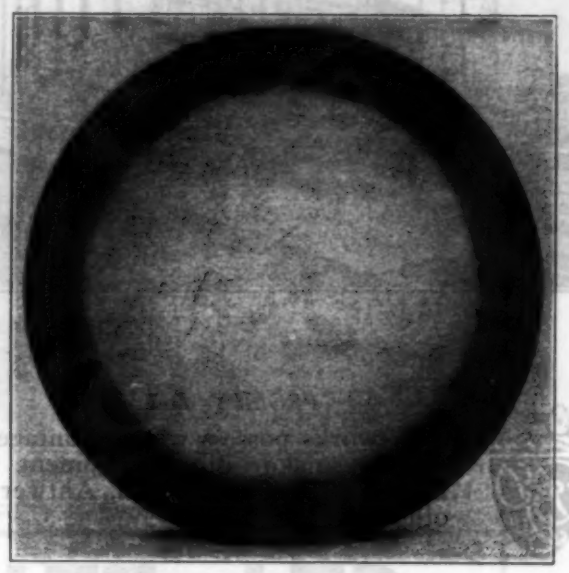

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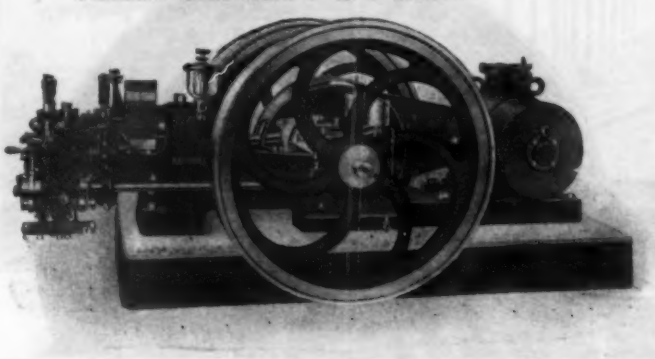

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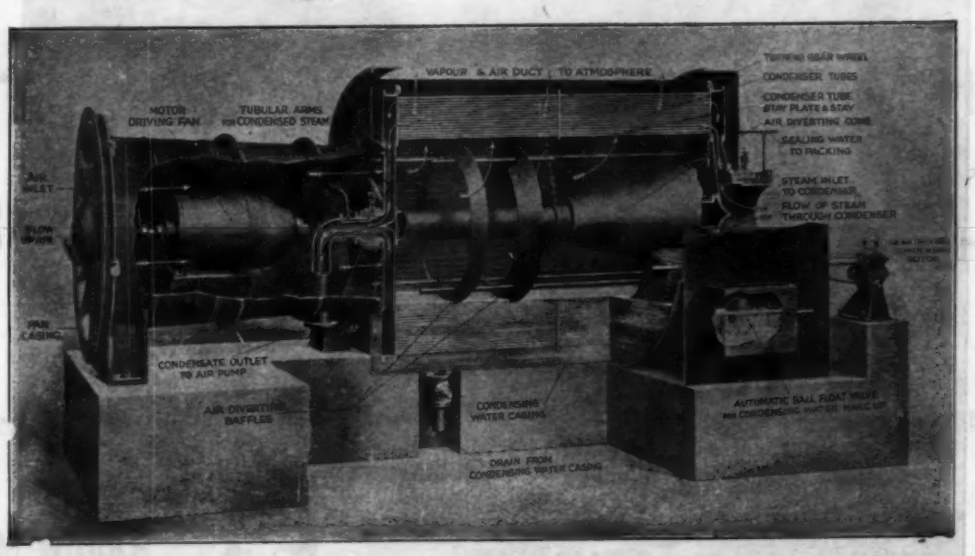
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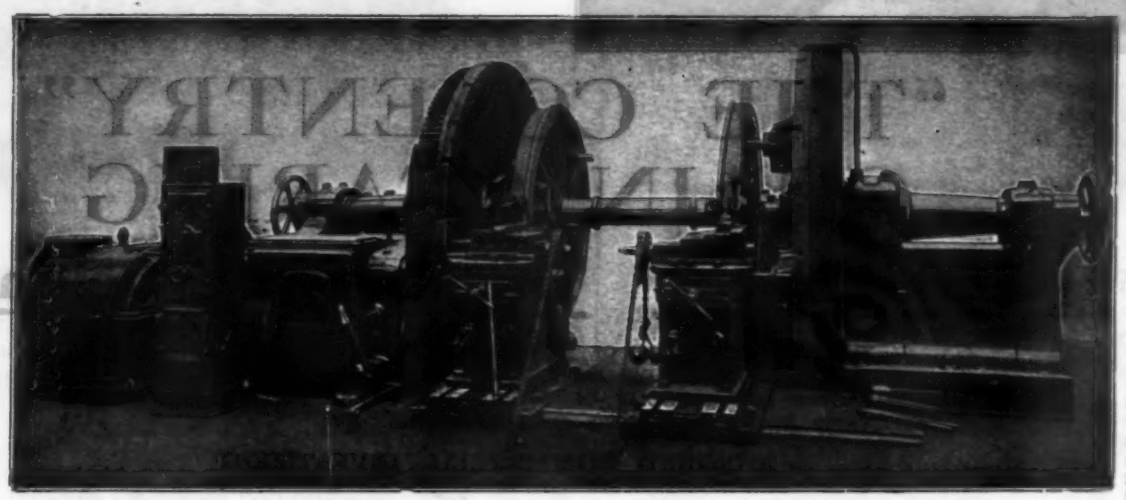

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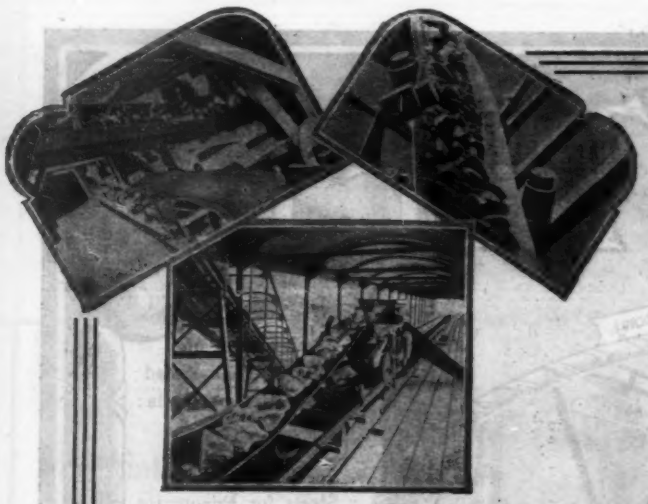

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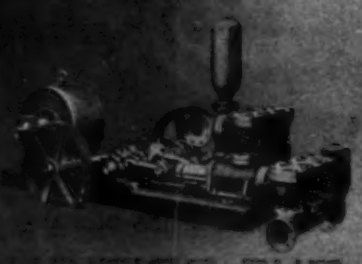

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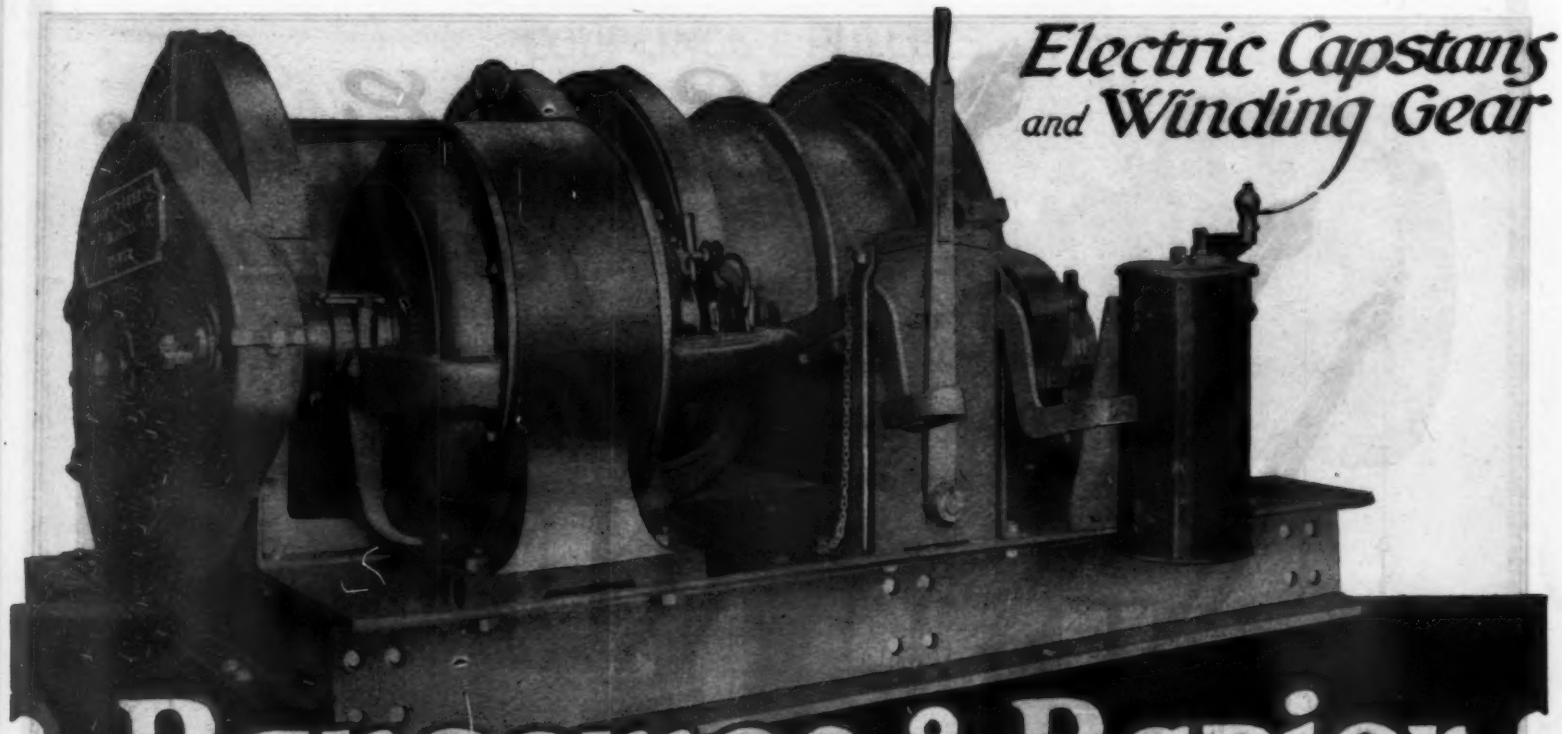

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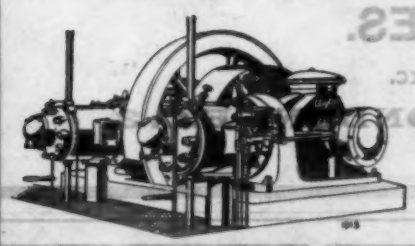

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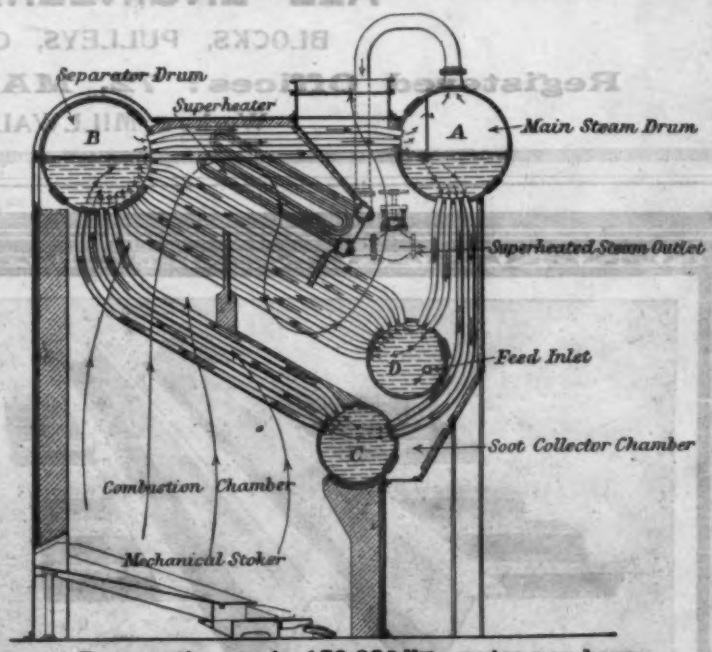

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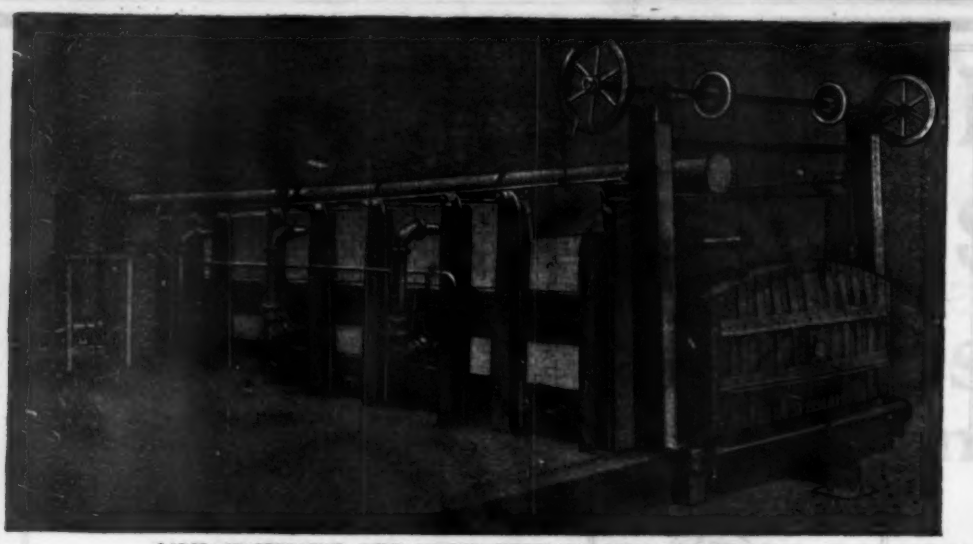

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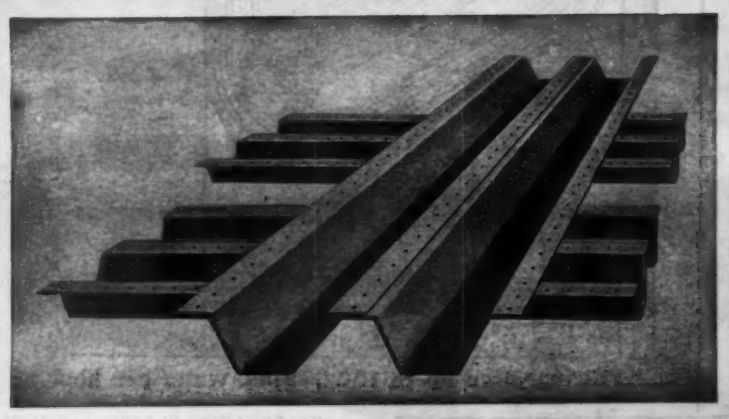

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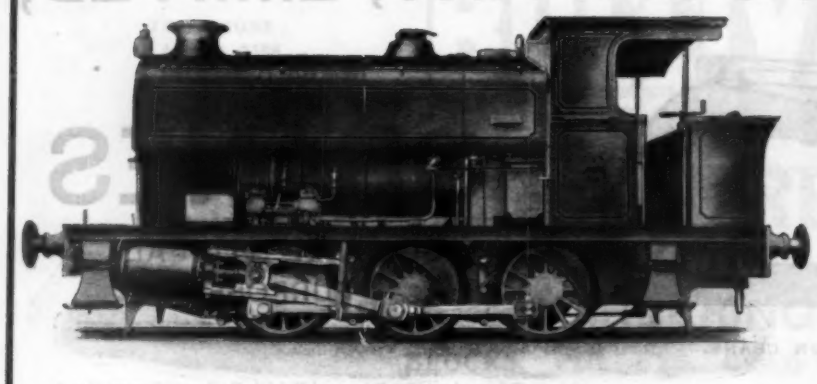

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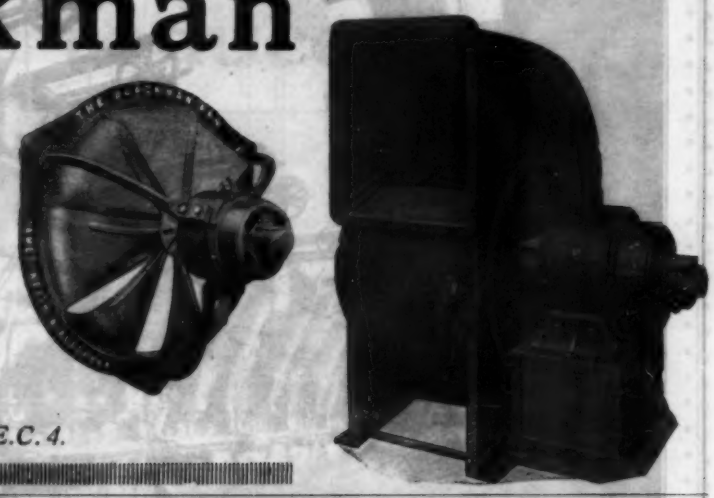

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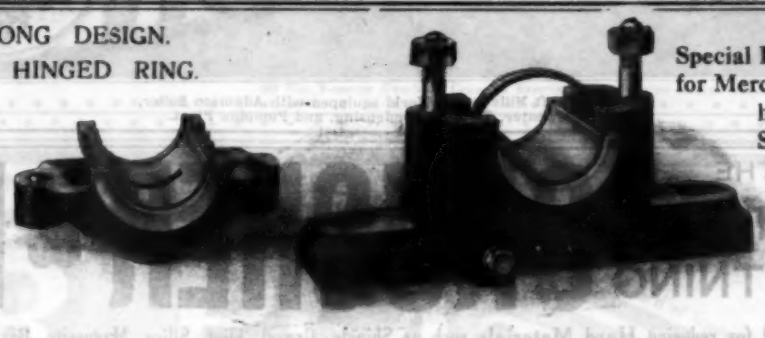

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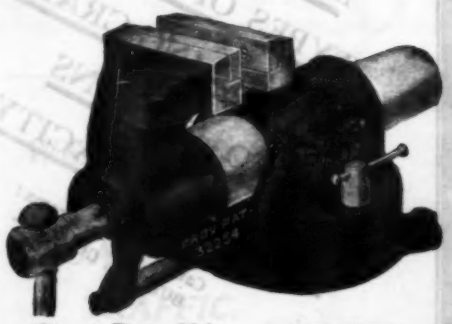

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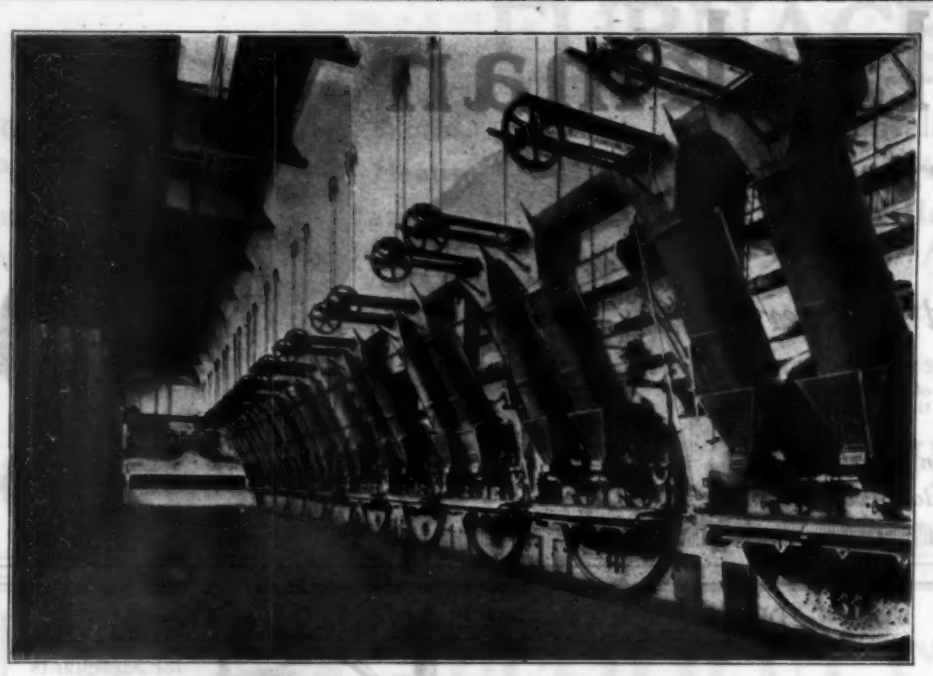

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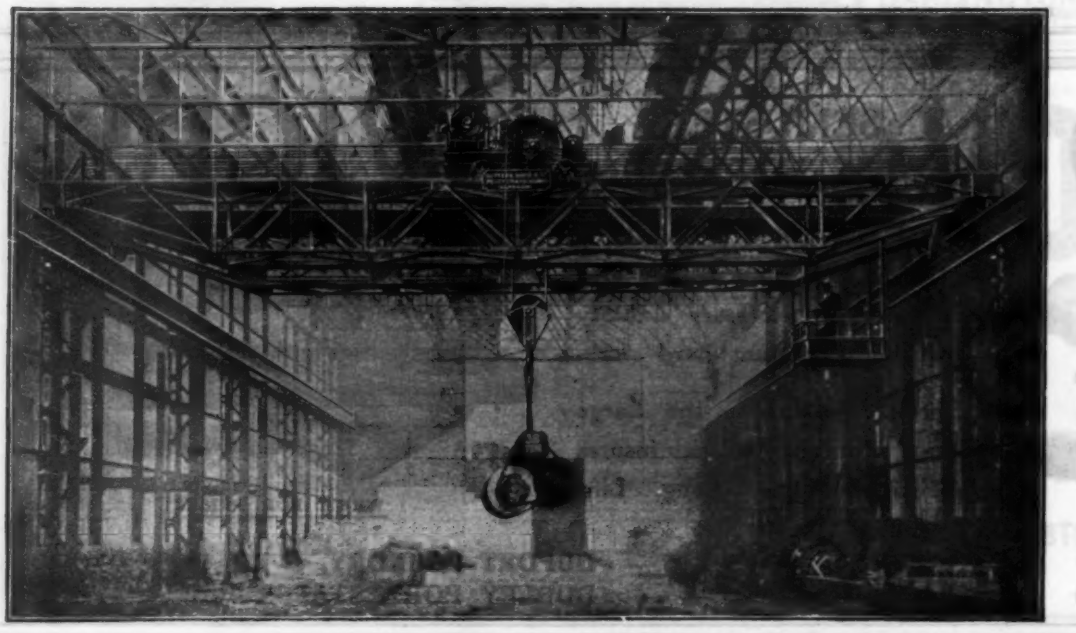

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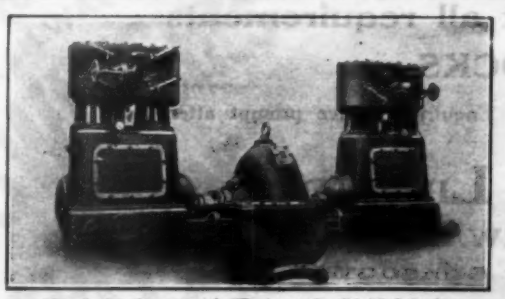

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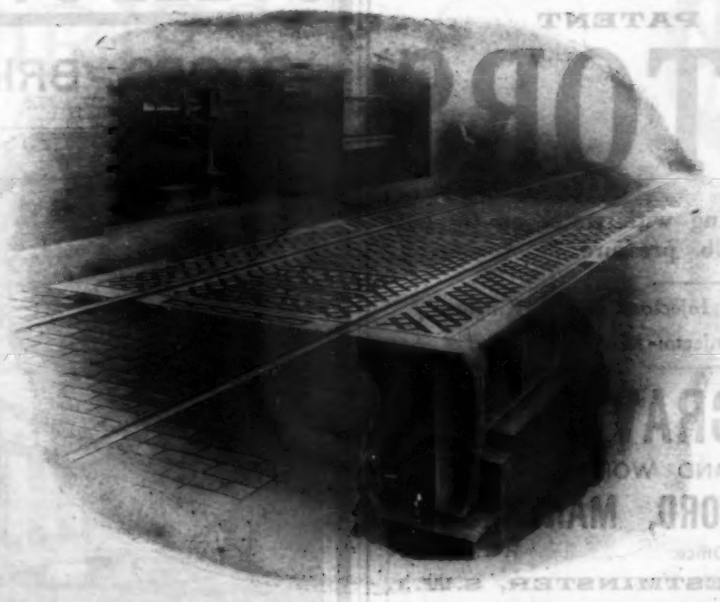

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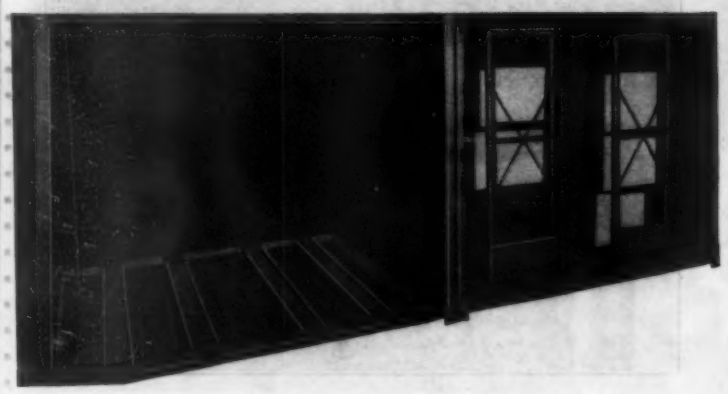

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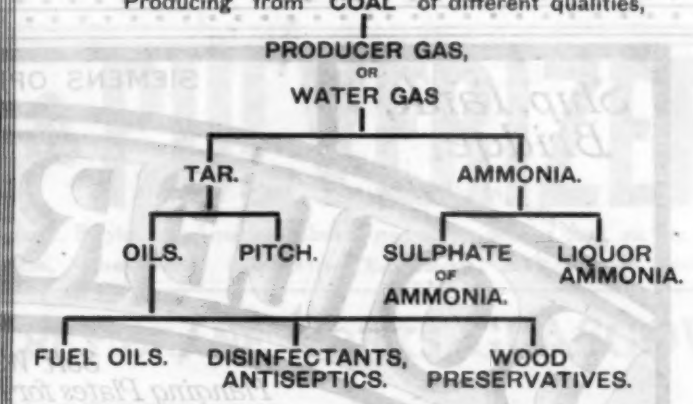

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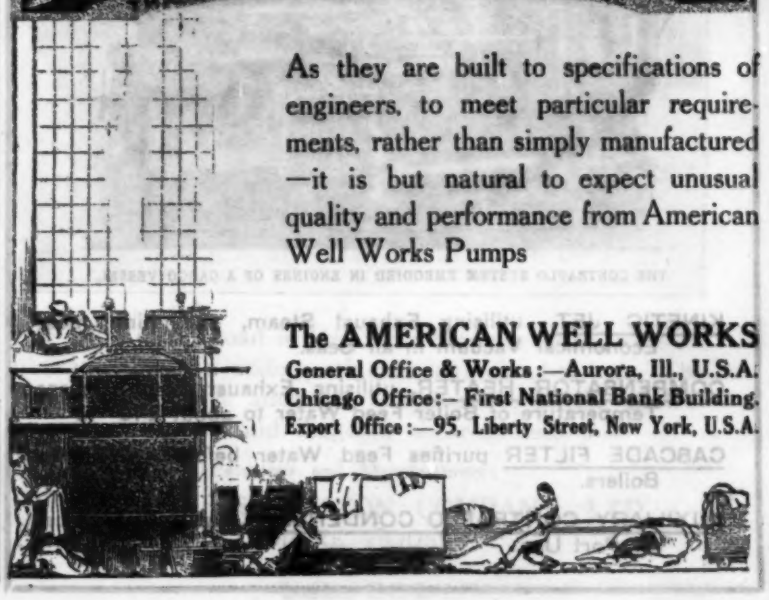

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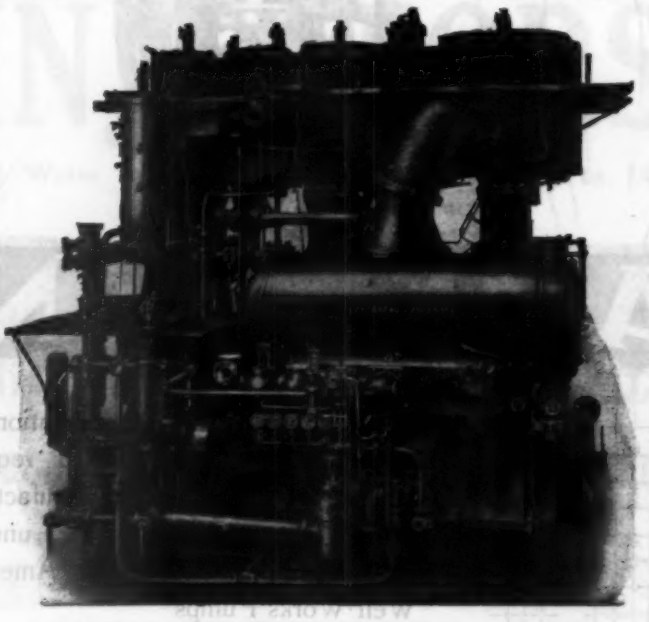

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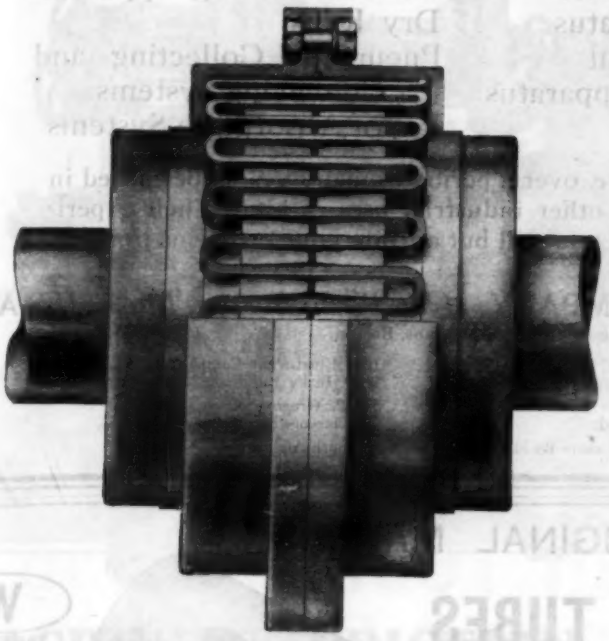

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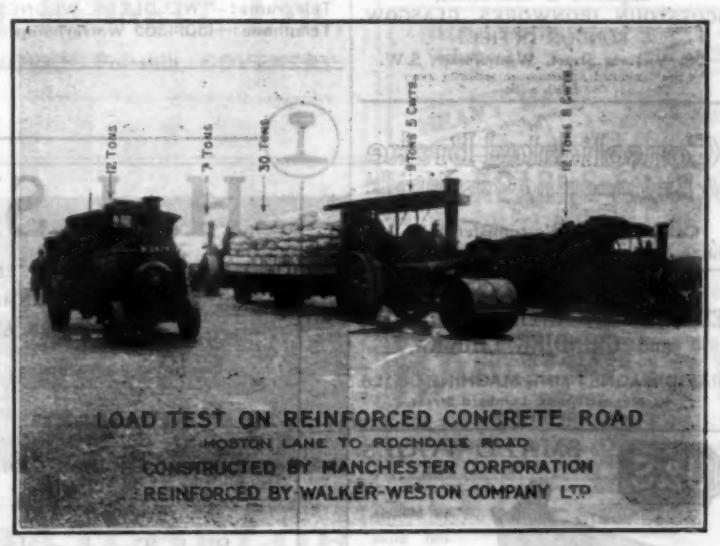

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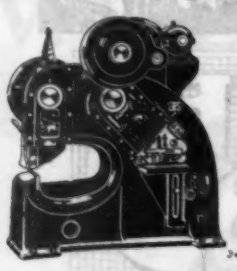

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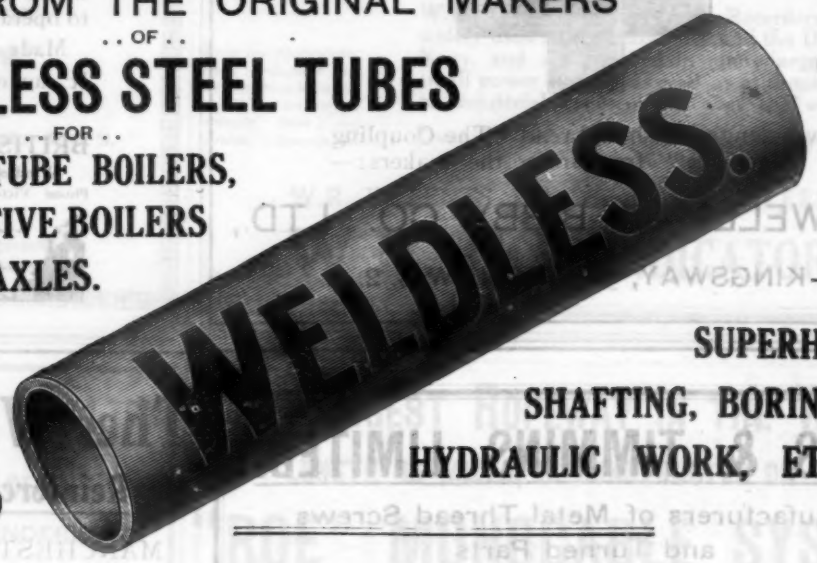

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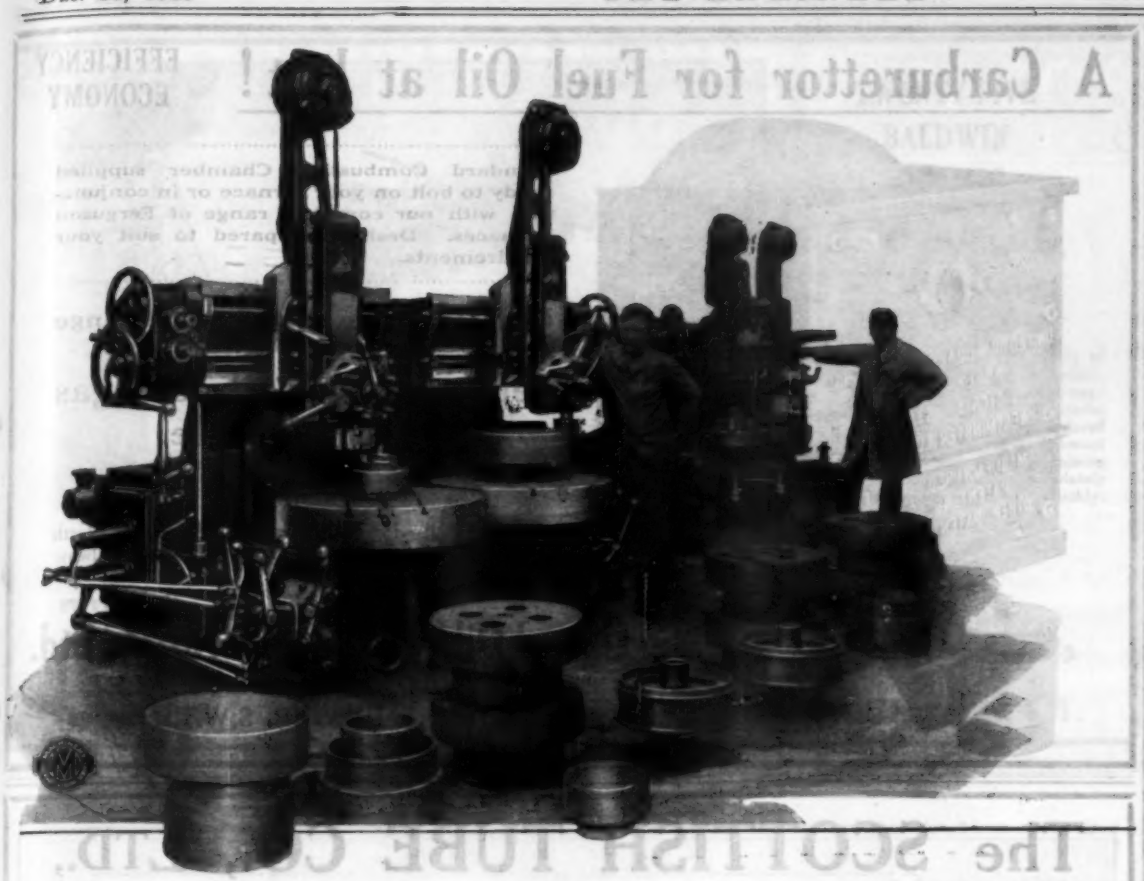

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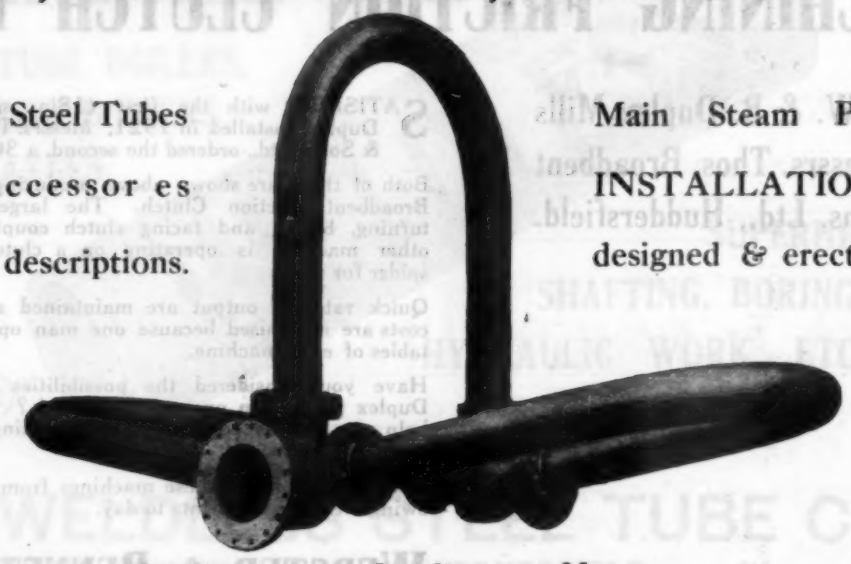

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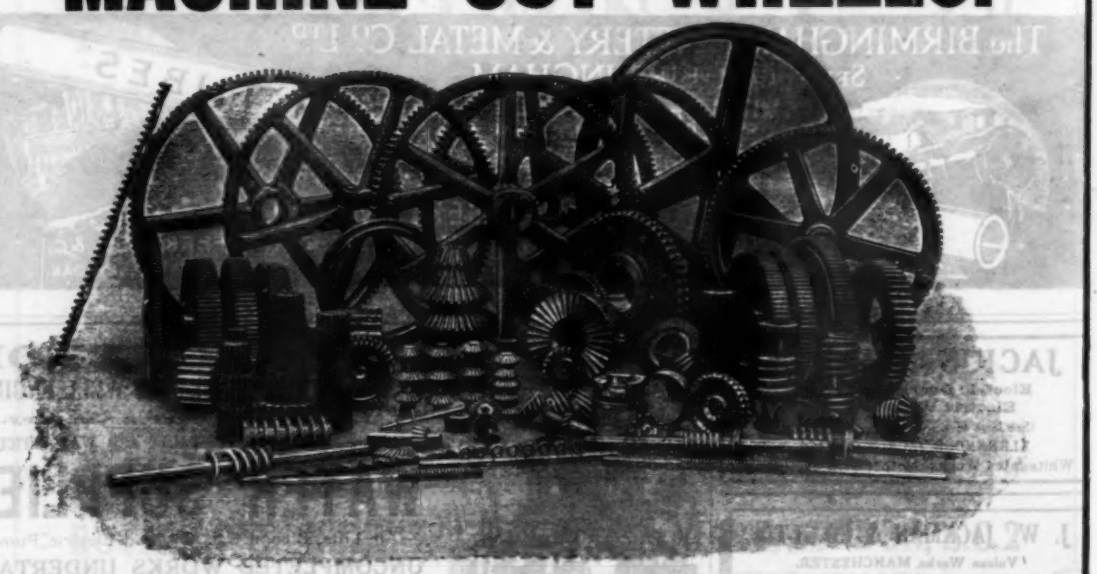

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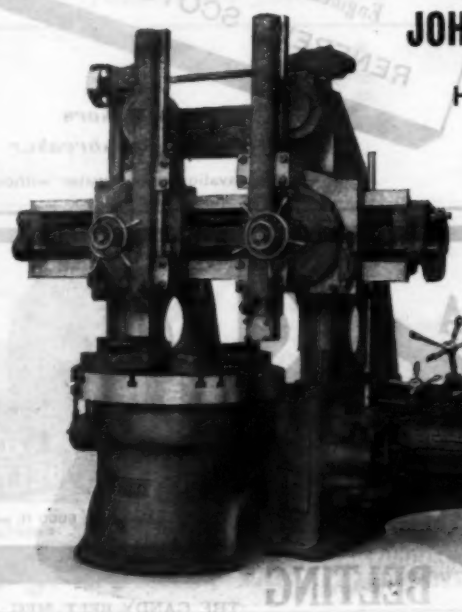

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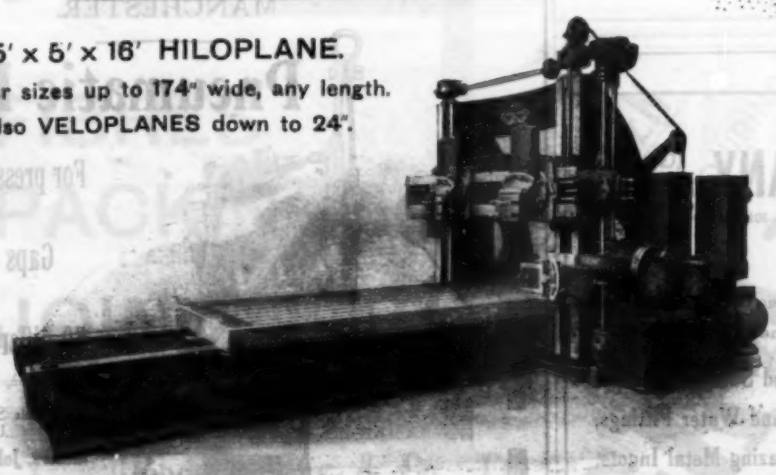

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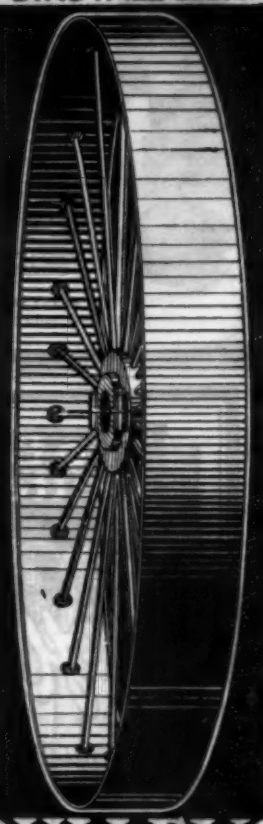

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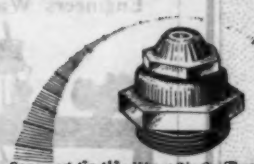

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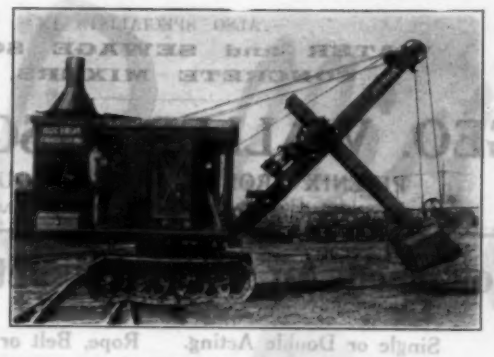

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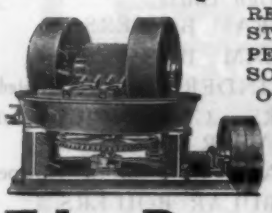

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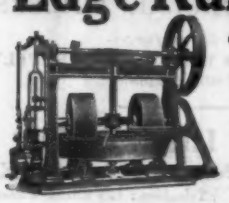

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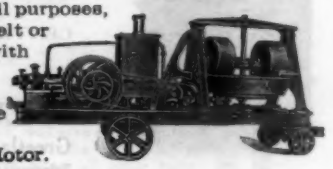

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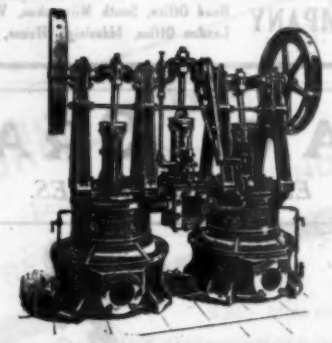

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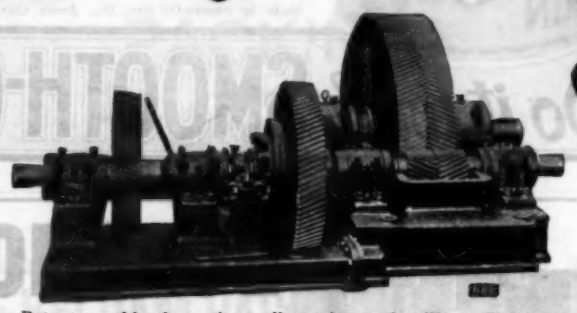

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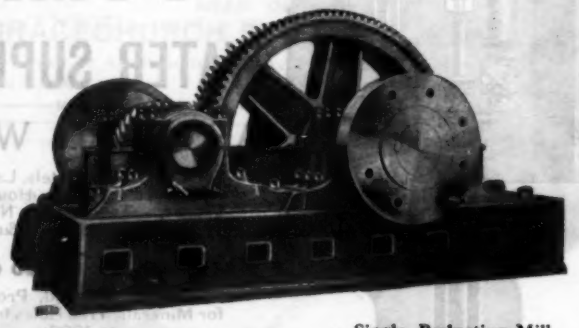

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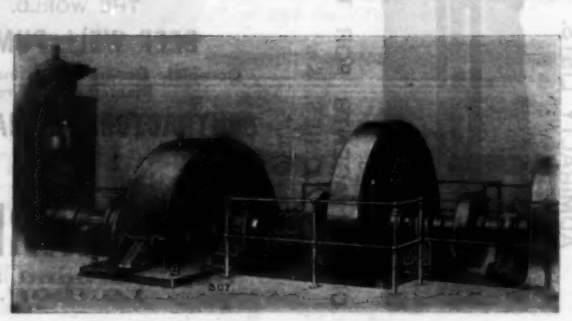

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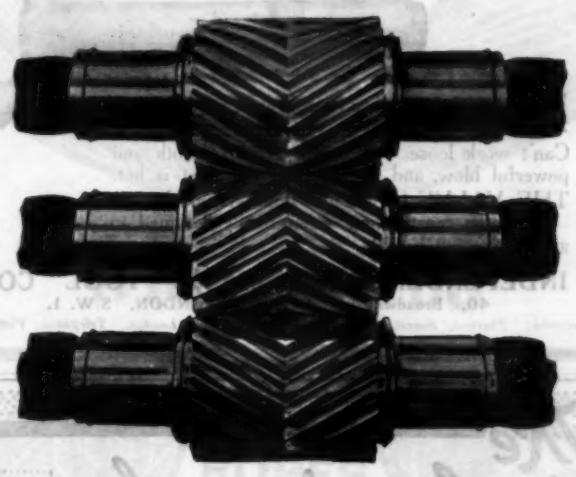

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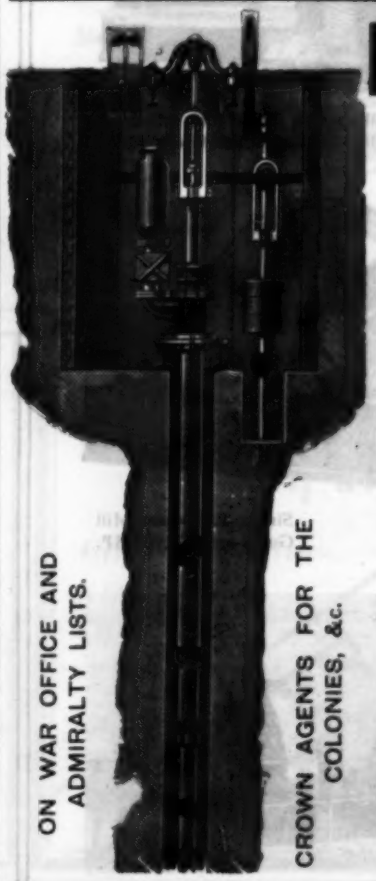

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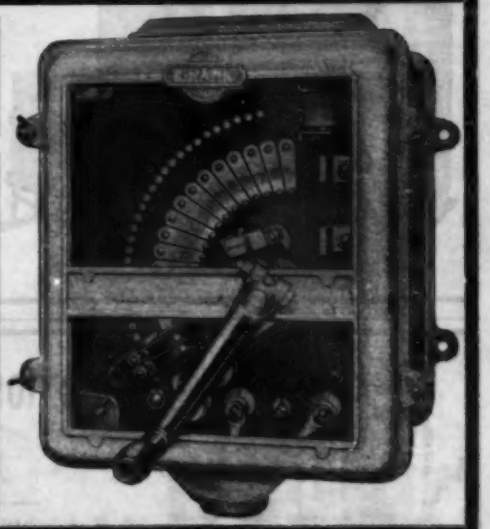

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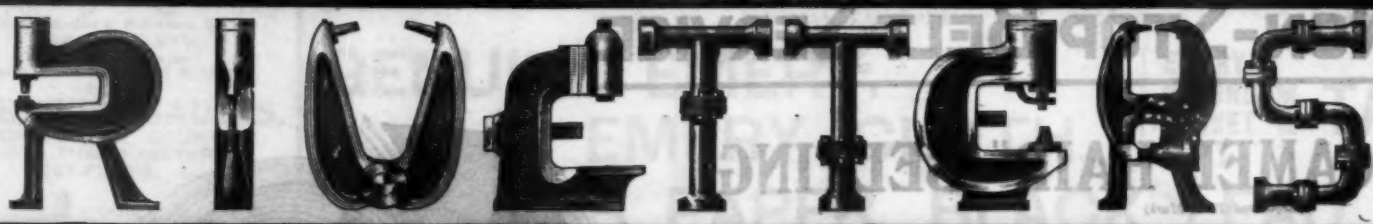

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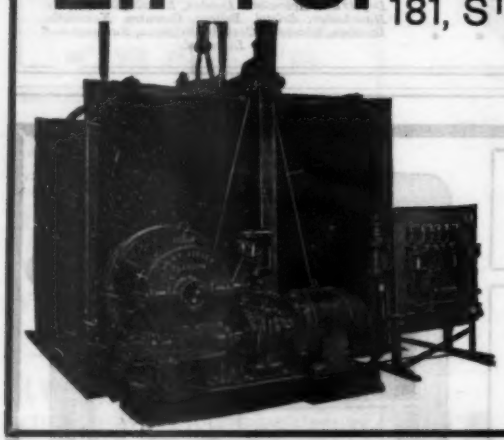

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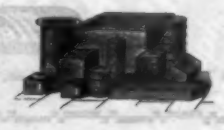

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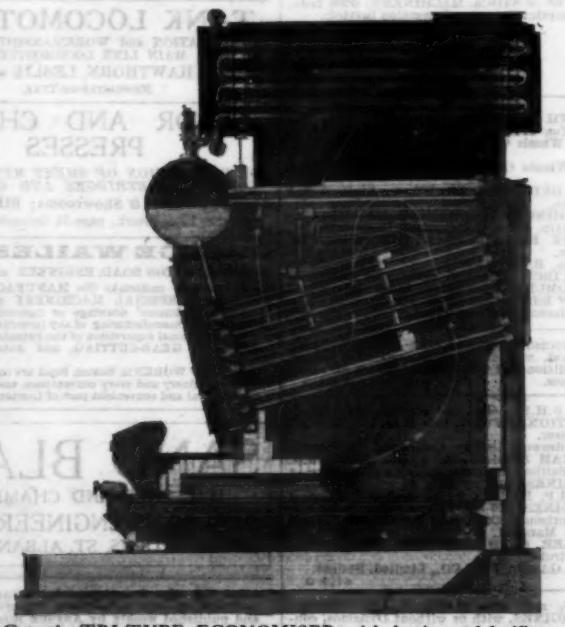

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